SCIENCE

8 January 1960
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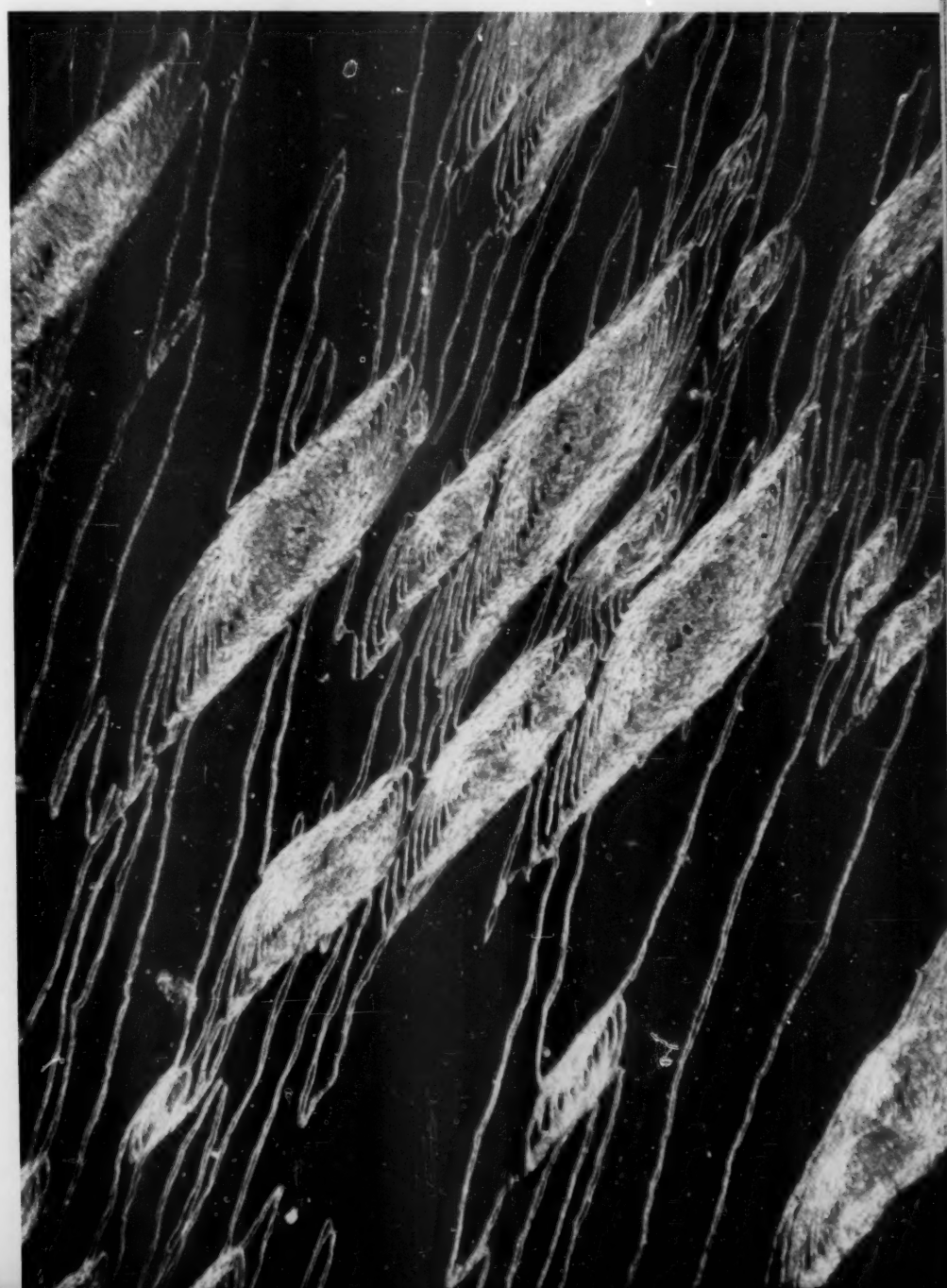
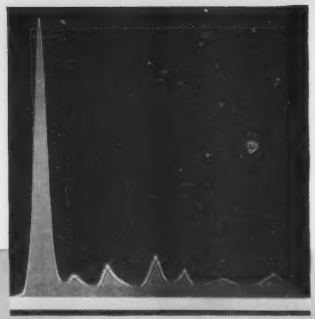
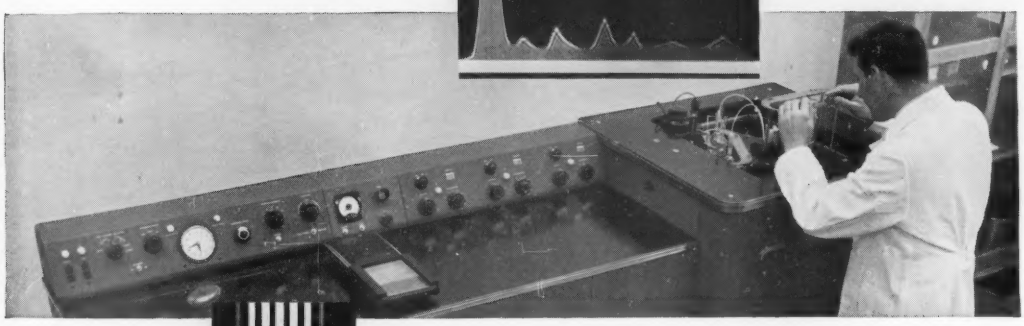
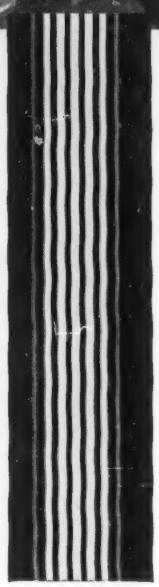
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





Electrophoresis of human serum diluted 1:6; ascending boundaries. Inclined knife-edge schlieren and Rayleigh fringes.





Typical reference fringe pattern obtained from standard production model.

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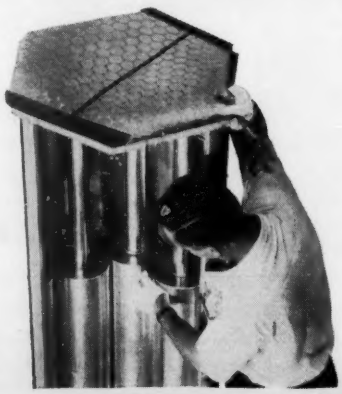

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SCIENCE

Cover

Domain boundaries in a magnetic substance: a thin film of nickel-iron alloy was formed by evaporating the alloy in a vacuum and condensing it, in the presence of a strong magnetic field, on a glass slide. After condensation, the film was slowly demagnetized by applying a cyclic field at right angles to the original field (about × 300). [From *Scientists' Choice*, with permission of the publishers, Basic Books]

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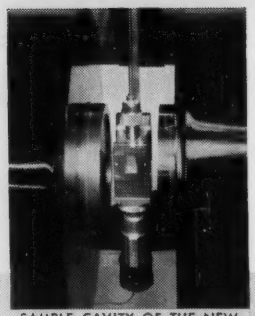

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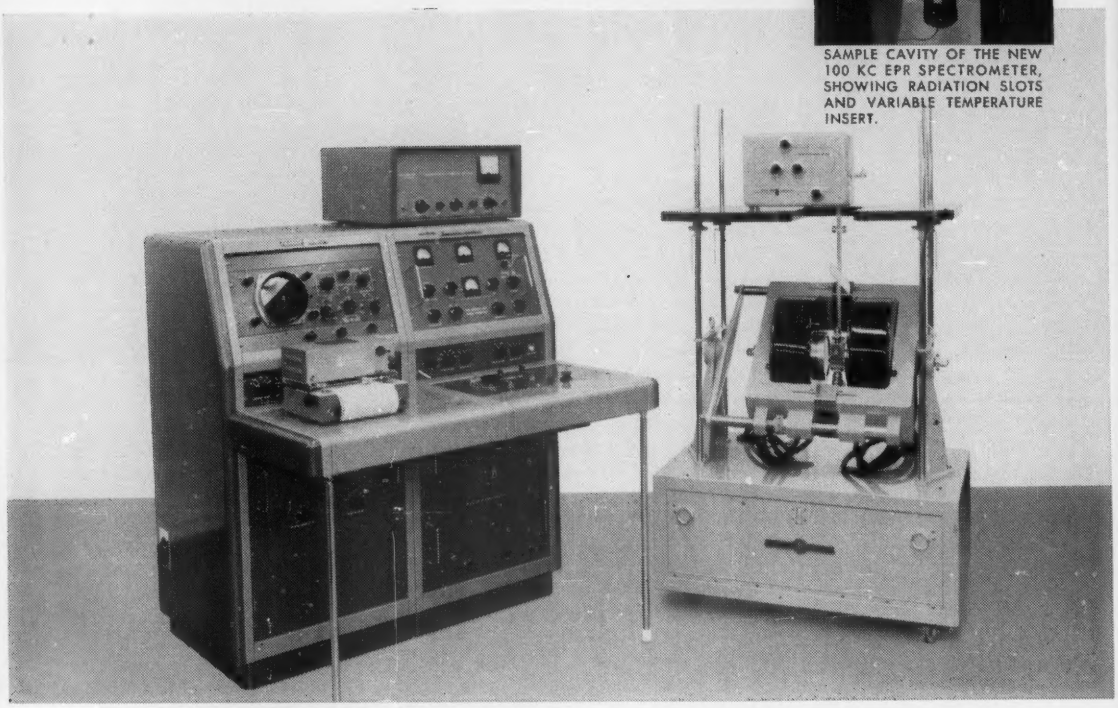

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Currently a broad diversity of programs are under way at MSVD, offering assignments of exceptional interest to engineers and scientists qualified to work with a research-oriented organization. Your inquiries are invited regarding the following areas: SYSTEMS ENGINEERING • AERODYNAMICS • THERMODYNAMICS • GUIDANCE & CONTROL • INSTRUMENTATION & COMMUNICATION • PLASMA PHYSICS • GAS DYNAMICS • AERO-MEDICAL DESIGN ENGINEERING • ANTENNA & MICROWAVE DESIGN • SPACE MECHANICS • STRUCTURAL DESIGN • ENERGY CONVERSION • HUMAN FACTORS • ADVANCED POWER SYSTEMS • RELIABILITY ENGINEERING • PRODUCIBILITY ENGINEERING • ARMING AND FUZING SYSTEMS • APPLIED MATHEMATICS & COMPUTER PROGRAMMING

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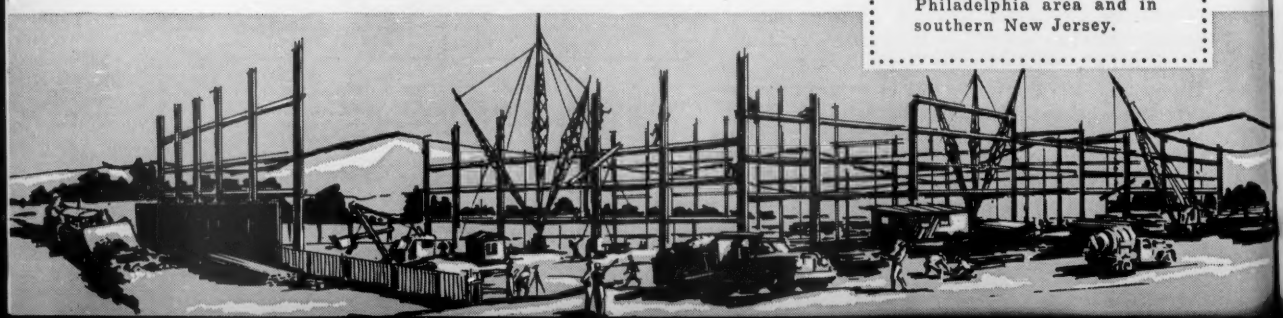

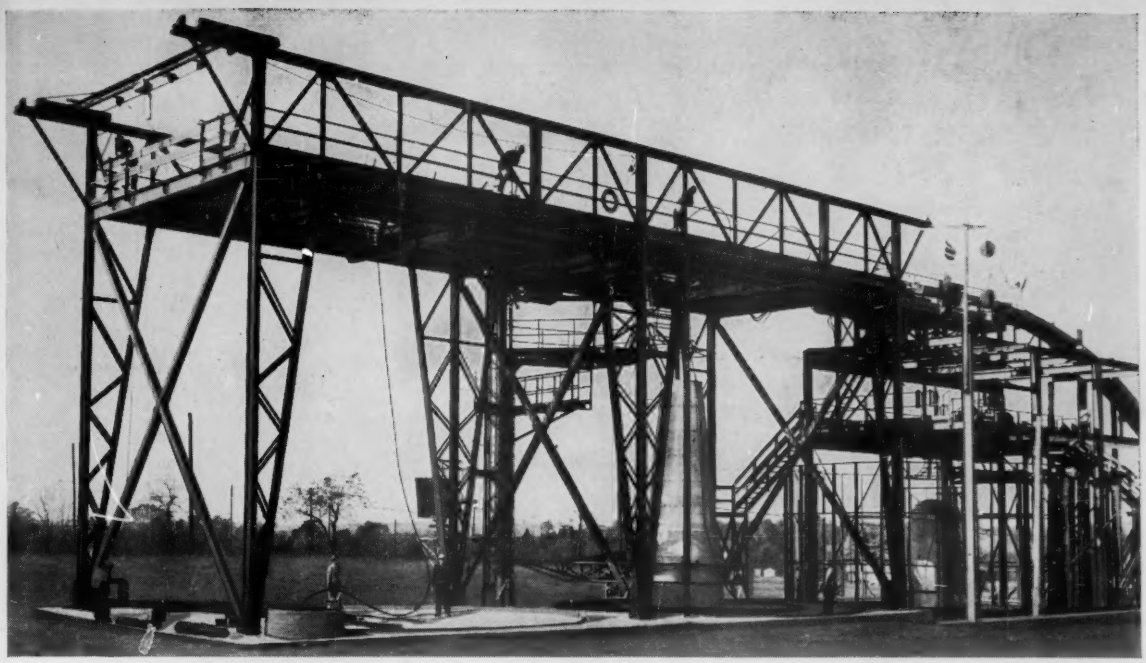

SHIP WITHOUT AN OCEAN

How do you lay a cable on the ocean floor—a cable that is connected to scores of large, heavy amplifiers? How do you "overboard" such a system in a continuous operation, without once halting the cable ship?

Bell Telephone Laboratories engineers must answer these questions in order to lay a new deep-sea telephone system designed to carry many more simultaneous conversations. They're experimenting on dry land because it is easier and more economical than on a ship. Ideas that couldn't even be attempted at sea are safely tested and evaluated.

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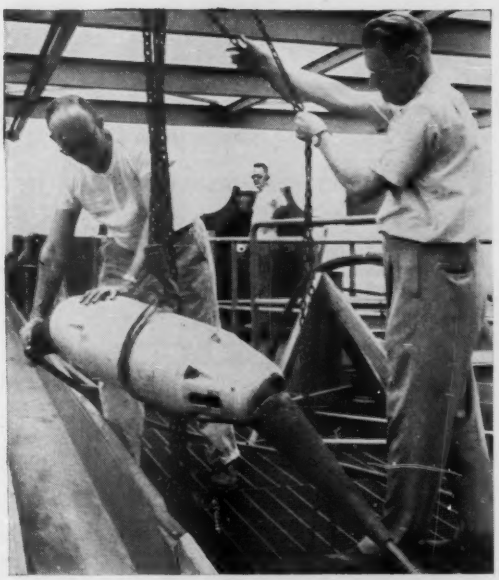
Elsewhere in the Laboratories, engineers learn how best to grip the cable and control its speed, what happens as the cable with its amplifiers falls through the sea, and how fast it must be payed out to snugly fit the ocean floor. Oceanographic studies reveal the hills and valleys which will be encountered. Studies with naval architects show how the findings can be best put to work in actual cable ships.

This work is typical of the research and development effort that goes on at Bell Laboratories to bring you more and better communications services.



Experimental amplifier about to be "launched" from "cable ship." Like a giant string of beads, amplifiers and connecting cable must be overboarded without stopping the ship.

BELL TELEPHONE LABORATORIES

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3. Solid state. Structure and behavior of crystalline and amorphous materials. Magnetics, radiation damage, structure determination. Experimental.

4. Solid state. Experimentalist to set up and supervise laboratory for measurement of properties and preparation of materials, (principally non-metals.)

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6. Theoretician in engineering physics or applied mathematician to work in hydrodynamics and other areas.

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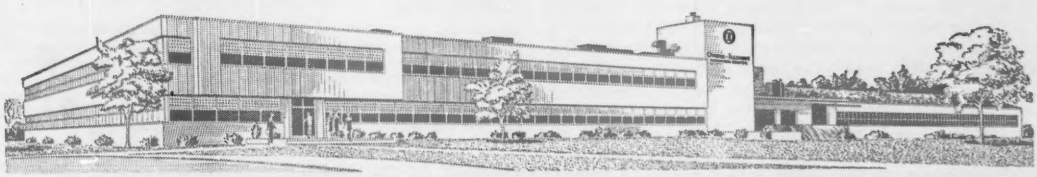

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- Control systems that remain efficient at temperatures in excess of 1500°F
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All of these programs – and many others – are being substantially augmented with a view toward the early occupancy of Republic's new $14 million Research and Development Center.

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REPUBLIC AVIATION

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Letters

"Thinking Claws"

In an article which appeared in *Science* [**127**, 521 (1958)], "Blocking by picrotoxin of peripheral inhibition in crayfish," by Van der Kloot, Robbins, and Cooke, the opening paragraph states: "In vertebrates, inhibition takes place within the central nervous system. But a crayfish 'thinks in its claws' "; this is followed by reference (*1*), which reads: "C. A. G. Wiersma, in *Recent Advances in Invertebrate Physiology* (Univ. of Oregon Press, 1957); P. Hoffman, *Z. Biol.* **63**, 411 (1914); **64**, 247 (1914)."

Any reader not familiar with the facts must be under the impression that either Hoffman or I is the author of this sentence. Since there is hardly any statement with which I disagree more strongly than the one quoted, I want to take this opportunity to point out that it does not occur in any of the papers referred to. It seems to have originated in Prosser's *Comparative Animal Physiology* (Saunders, Philadelphia, 1950), where, on page 597, the statement "A crab 'thinks in its claws' " appears as far as I know for the first time in literature, notwithstanding the quotes. As this is a type of slogan which apparently leaves a lasting impression in many minds, but is completely false in content, I hope this note will contribute to its everlasting suppression.

C. A. G. WIERSMA
Division of Biology, California Institute of Technology, Pasadena

We are sorry that Wiersma dislikes the phrase, because his studies on crustacean muscle are so important. Our reference was misleading; the disputed phrase in fact was quoted from C. A. G. Wiersma, *Symposia on Quantitative Biology* **17**, 157 (1952). As it does not appear in quotation marks, we mistakenly assumed that Wiersma was its author. I agree that—if taken literally—the "slogan" is untrue and is the stuff of poetry rather than of science. On the other hand, the phrase is more than fiction; it is a creative account of the integration of nerve impulses which goes on at a crustacean muscle. And the literature of science would be poorer if robbed of the factitious. Who would want to bury the obvious untruth, "Life has an itch to live" [C. S. Sherrington, *Man on his Nature* (Cambridge, 1951), p. 170], or never speak again of "the wisdom of the body" (W. B. Cannon), when these phrases, like the one in question, express fundamental biological ideas in an exhilarating fashion?

W. G. VAN DER KLOOT
Department of Pharmacology, New York University, New York

Cholinesterase Inhibitors

The 7 Nov. 1958 issue of *Science* [**128**, 1136 (1958)] carried a challenging article by W. H. Orgell *et al.*, entitled "Inhibition of human plasma cholinesterase in vitro by extracts of solanaceous plants."

The authors of this article have unquestionably demonstrated the existence of a cholinesterase inhibitor in extracts of solanaceous plants. Nevertheless, in my opinion, the quite plausible possibility that steroidal amine glucosides were present was rather lightly dismissed. The possibly unintentional neglect to acknowledge this distinct possibility might lead to a rather fallacious impression on the part of the casual reader, and therefore I wish to contribute a few thoughts of general interest.

The rather simple and crude preparation of plant extracts described in the article does by no means remove solanine (or solanidine in its numerous forms) from the substrate, nor from suspicion. Furthermore, the inhibition pattern for various parts of the potato plant or tuber coincides remarkably with that of solanine distribution. I do not propose to claim that solanine, in spite of its pronounced physiological and hemolytic action, is associated or directly responsible for cholinesterase inhibition. This is more probably due to the presence of free alkaloid solanidine, the product of enzymatic or acid solanine hydrolysis. Solanine alone has been resolved into alpha, beta, and gamma fractions, the latter presumably an artifact of the extraction procedure (*1*). Apparently the alkaloid solanidine has a wider occurrence than was assumed heretofore, since it is also the building block of three forms of chaconine in potato leaves. The possible presence of these steroidal amines in potato-plant extracts must not be overlooked, particularly in view of our

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Letters

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limited knowledge of their physical and chemical nature. In this respect it is noteworthy that potato tubers with high levels of solanine are considered toxic and dangerous for human consumption.

I attribute the toxic effects of such tubers to the presence of free solanidine in tuber tissues (*2*). In other words, the remarkable structural similarity to cholesterol is indicative of a relatively easy diffusion of solanidine into the blood stream, while the absorption of solanine appears to be blocked in the digestive tract (*3*). Thus, one is not far from the thought that the toxic effects may be linked, at least in part, with a direct action of solanidine upon the cholinesterase system.

A. ZITNAK

Department of Horticulture, Ontario Agricultural College, Guelph, Canada

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1. R. Kuhn and I. Löw, *Ber. wiss. Biol. (Abt. A Ber. ges. Biol.)* **88**, 1492 (1955); *Chem. Abstr.* **51**, 1990g (1957).
2. A. Zitnak, paper presented before the Agricultural Institute of Canada, Wolfville, Nova Scotia (26 June 1958).
3. R. Rühl, *Arch. Pharm*, **284**, 67 (1951); *Chem. Abstr.* **45**, 7256 (1951).

We are in general agreement with Zitnak's suggestions regarding cholinesterase inhibition by the steroidal alkaloid glycosides and feel that his hypothesis for the physiological action of these substances merits investigation. To support the possibility that solanine, chaconine, and related glycoalkaloids are chiefly responsible for the inhibition of plasma cholinesterase by potato extracts, we would like to call attention to the report of Pokrovsky (*1*), who determined that solanine and solanidine were powerful inhibitors of horse serum cholinesterase, the aglycone solanidine being approximately twice as inhibitory as solanine in his tests. Pokrovsky also found that solanine was approximately 25 times more inhibitory (on the basis of I_{50} values estimated from graphical data) to nonspecific (horse serum) cholinesterase than to specific (rabbit brain) cholinesterase. This corresponds to our own results on comparing the action of potato-leaf extract against nonspecific (human plasma) and specific (human red cell) cholinesterase and perhaps has some bearing on the genetic differences between human beings in the response of their serum cholinesterase to Nupercaine and the inhibitor from potato extracts, as reported by Harris (*2*). We have confirmed Pokrovsky's observations with our own preparations of crystalline alkaloid from Irish Cobbler tuber sprouts, and also have noted the correspondence between the distribution of solanine (*3*) and inhibitor in the potato plant. We might point out that Pokrovsky has also suggested that the symptoms of solanine poisoning might reflect the cholinesterase inhibitory properties of solanine.

However, we would like to emphasize that there may be cholinesterase-inhibitory substances present in extracts of solanaceous plants other than the steroidal amine glycosides and their derivatives. As a specific example, we have found that aqueous extracts of the common garden petunia are a very potent source of cholinesterase inhibitor (I_{50} = 6 mg of fresh leaf tissue against 5 ml of human plasma), yet no precipitate forms on alkalinization to *p*H 10, as would be expected if solanine or related substances were present (*4*), and the extracts do not give the usual color reactions for the steroidal amine glycosides. Our method of extraction was developed specifically for rapid routine assay of the total cholinesterase inhibitory potency of large numbers of plant-tissue samples, and our extracts certainly contain the steroidal amine glycosides as well as other inhibitory substances.

An interesting question arises in regard to the "function" of these potent natural enzyme inhibitors in higher plants. Fraenkel (*5*) suggests that alkaloids and other secondary plant substances may have arisen in evolutionary response to selection pressure exerted by insects and other parasites and predators. We are currently studying the possibility that natural enzyme inhibitors represent a protective mechanism against the extracellular digestive enzymes secreted by many insects and plant pathogens.

W. H. ORGELL
KUNDA A. VAIDYA
P. A. DAHM

Department of Zoology and Entomology, Iowa State University, Ames

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1. A. A. Pokrovsky, *Biokhimiya* **21**, 683 (1956).
2. H. Harris and Mary Wittaker, *Nature* **183**, 1808 (1959).
3. L. H. Lampitt *et al.*, *J. Soc. Chem. Ind. (London)* **62**, 48T (1943).
4. M. J. Wolf and B. M. Duggar, *J. Agr. Research* **73**, 1 (1946).
5. G. S. Fraenkel, *Science* **129**, 1466 (1959).

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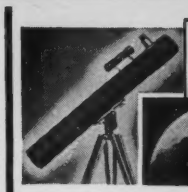

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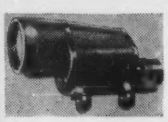

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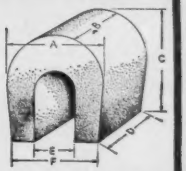

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Small Colleges and Small Minds

Although the place of scientific research in the independent liberal arts college is not so clearly defined as its place in a university, the contribution that research can make to education seems so clear that we wonder why, if research is welcomed in some liberal arts colleges, it is opposed in others. The core of the argument for scientific research, as pointed out by Laurence M. Gould, president of Carleton College, in an article in the AAAS volume *Symposium on Basic Research*, is that while there may be good research scientists who are not good teachers, the evidence is that there are no good teachers whose competence is not increased by good scholarship. Yet the instructor in an independent liberal arts college who opposes research tells us that *his* institution is a teaching college, that research is good and teaching is good but the two are incompatible.

The theory that the conscientious teacher, as distinct from the overworked teacher, simply has no time for research may be endorsed explicitly by the administration of a college or by influential members of particular departments in a college, but it may also receive a kind of indirect support. A prominent figure on many campuses is the instructor who is forever marking exams, grading papers, and drawing curves representing his students' performance. He is full of schemes, such as giving comprehensive examinations to the entire student body, that if instituted would require the assistance of all his colleagues. With such a person on hand, it soon appears that any instructor who so much as opens a book is goofing off just as surely as the student who cuts classes to improve his bridge.

To be sure, the administration of scientific research on a college campus poses many problems. Should the teaching load of an instructor who gets a grant for research be reduced? Should his salary be reduced? If the grant does not include salary, how much time should the college allow the instructor for his research? What percentage of the grant should the college charge for the use of its facilities and equipment? But these problems, if troublesome, can be solved. They are not arguments against the contribution that scholarship can make to effective teaching.

Instructors may all agree that in a liberal arts college the quality of teaching is the most important consideration. They may also agree that one can be a first-rate teacher without doing a stick of research, and that research, like teaching, can become a device for keeping oneself busy without actually working. But why in small colleges should some instructors oppose the recognition of good research as a consideration second to good teaching? The real reason is not one of those mysteries that science cannot explain. Consider the effect of such an additional consideration on faculty promotions and prestige—and even on the ability of a college to acquire teachers of merit. We suspect that some instructors oppose research, and other forms of scholarship as well, because, when a college encourages scholarship, competition for positions on its staff grows sharper.—J.T.

8 January 1960, Volume 131, Number 3393 SCIENCE

CURRENT PROBLEMS IN RESEARCH

New World Prehistory

The main outlines of the pre-Columbian past are only beginning to emerge.

Gordon R. Willey

The prehistory of the New World is so multifaceted and complex that synthesis demands not only compression but rigorous selection. What strands of human activity can be followed most easily through the maze of the past? Which elements are the significant ones? These are always troublesome questions for the archeologist, and in the present case they are made more so by the tremendous range of space and time and by the quantity and quality of the data with which we are dealing. It is difficult to fix consistently upon criteria of comparison. The best we can do is to adhere to those universal themes of man's existence that leave their mark in or upon the earth: technology, environmental adaptation, subsistence, and settlement. These were not necessarily determinative of the form and elaboration of other aspects of man's life, but they provide a background and a base which is necessary to the understanding of societies and cultures in pre-Columbian America.

Major Problems in New World Archeology

Before beginning this account of New World prehistory it will be well to review some of the major problems confronting the American archeologist, for it will be evident that the tentative conclusions which I have reached about these problems give the outline and structure to the present article. They are problems not unlike those of Old World prehistory (*1*, *2*) in that they are concerned with the great changes in man's adaptations to his natural and social environments.

Most briefly, and in approximate chronological order, these problems are as follows.

1) Who were the earliest inhabitants of the New World? Were they food gatherers comparable in their simple subsistence technology to the peoples of the Old World lower and middle Paleolithic?

2) Where and at what time did the American big-game-hunting specialization of the Pleistocene arise? What were its relationships to the possible earlier food gatherers mentioned above? What were its relationships to the big-game-hunting tradition of the Old World? What happened to the pattern?

3) What were the origins and relationships of the specialized food-collecting subsistence patterns of the post-Pleistocene? Did Asiatic diffusions and migrations play a part in these developments, especially in the Arctic and Boreal zones?

4) Where and when were food plants first domesticated in the New World, and what was the effect of this on society and culture?

5) What is the history of pottery in the New World?

6) At what period and in what regions did sedentary village life based upon farming arise in the New World, and what was the history of the spread of this pattern in native America?

7) What was the nature of sedentary village life in the New World in those areas or regions where plant cultivation was poorly developed or lacking, and when did it occur? To what extent were such cultures and societies dependent upon the diffusion of ideas and elements from the village-farming pattern?

8) When and how did the native civilizations of Nuclear America come into being? What were their relationships within the Nuclear sphere? What were their relationships to non-Nuclear America?

In the statement of these problems and in the discussion that follows, certain terminology is used that needs explanation. This terminology also relates to the three diagrammatic charts (Figs. 1–3) which summarize New World prehistory in broad eras or stages of subsistence technology (earlier chronological ranges) or settlement types (later chronological ranges). The term *food gathering* is applied to subsistence patterns where the gathering of wild plant foods or the hunting of animal life lacked regional specialization or technological diversification. This usage follows that of Braidwood in Old World archeology (*3*). *Food collecting*, in contradistinction, implies both specialization and diversification in the taking and utilization of wild plant and animal foods. The other terms descriptive of types of subsistence and settlement—*incipient cultivation*, *village farming*, *towns and temples*, *cities*, and a few other special terms of this nature—are defined below.

The geographical arrangements and the designations of the charts deserve a word. Figure 1 is a cross section for an area that runs north and south through the western axis of the hemisphere. The name *Nuclear America* refers to the southern two-thirds of Mexico, all of Central America, and Andean and coastal Colombia, Ecuador, and Peru, with adjacent portions of Bolivia. This was the heartland of native American agriculture and the seat of the two pre-Columbian centers of civilization, one in Middle America (Mexico-Guatemala) and the other in Peru-Bolivia (*4*). There is a column for each of these two centers on the chart, and the column between, headed

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"Intermediate," refers to what I am calling the "Intermediate area" of southern Central America, Colombia, and Ecuador (*5*). To the north of Nuclear America is western North America, divided into the Southwest culture area and the adjacent Great Basin area. Under "Southern South America" are columns headed "South Andes" and "Pampas-Patagonia." Figure 2 is a cross section for an area extending from the Intermediate area of Nuclear America eastward across Venezuela, then southeastward to the Amazon drainage basin and eastern Brazil,

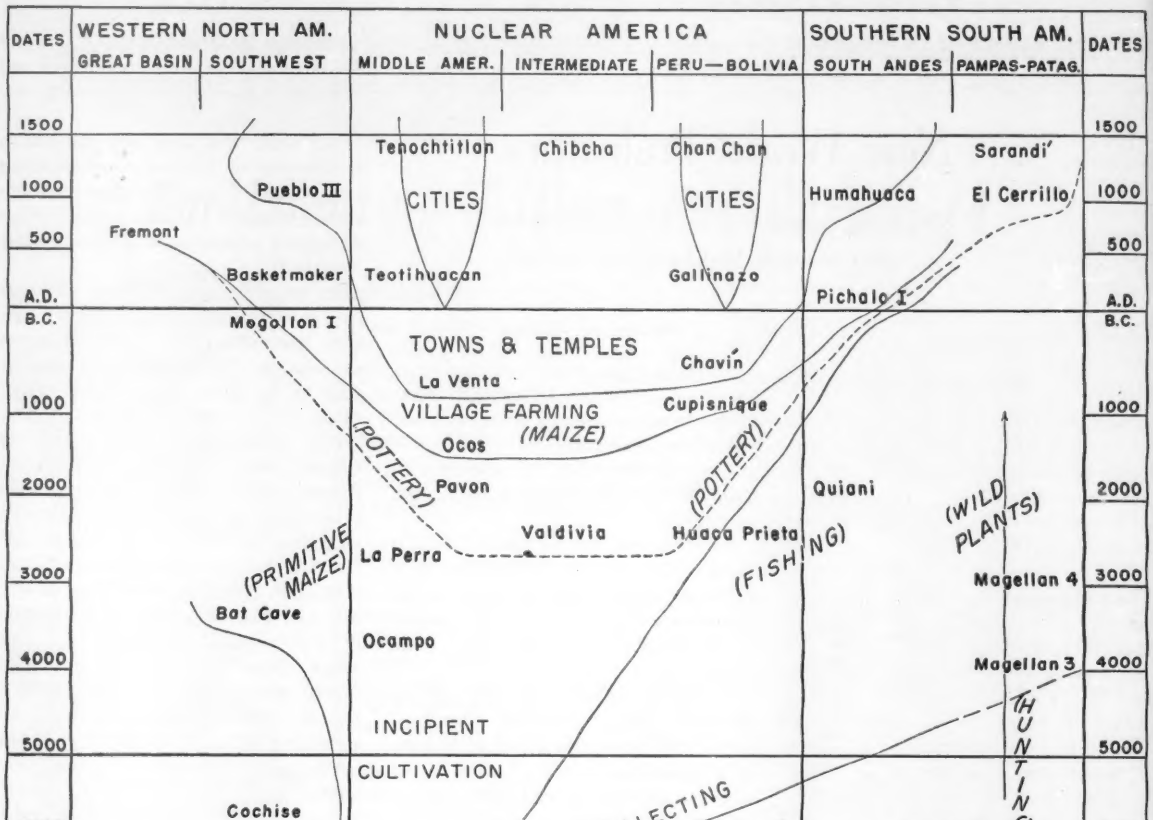

Fig. 1. Subsistence and settlement type levels in native America: cross section for western North America, Nuclear America, and southern South America. The first appearance of pottery is indicated by the dotted line.

and finally south to the Pampas-Patagonia region. In Fig. 3 the "Middle America" column is repeated under "Nuclear America," and the cross section is extended to include the North American eastern woodlands and plains areas. The charts are highly schematic, and only a small number of archeological cultures, or phase names, have been entered in the columns for various areas. (These names appear in small letters.)

The point should be made that the diagonal and curving lines which mark off the major subsistence and settlement types on the charts are not impermeable ones (see *1*, Fig. 6). Influences and traits crossed these lines, frequently moving outward from areas of cultural complexity and intensity into areas of simpler cultures. Such traits were often assimilated by the receiving groups without effecting basic changes in subsistence or settlement. In some instances suspected diffusions of this kind are indicated on the charts by means of arrows.

Pleistocene Food Gathering (?)

There are scattered finds in the Americas which suggest by their typology and chronological position that they may be the remains of early food-gathering societies (*2*, pp. 82–86; *6*). These artifacts include rough, percussion-chipped flint choppers, scrapers, and possibly knives or points, and occasional worked bone splinters. In some places, such as Tule Springs, Nevada, or Friesenhahn Cave, Texas, these crude weapons and tools have been found associated with the bones of extinct Pleistocene mammals, so it is likely that some hunting, even of large game, was practiced (*7*, pp. 197, 218). In general, however, the technological aspects of the implements show a lack of specialization toward hunting or toward any other particular means of obtaining food. In this the artifacts, and the inferences made from them, are analogous to those for the food-gathering cultures of the Old World lower and middle Paleolithic (*8*).

In age and geological placement, such putative early food gatherers in the Americas are not, however, comparable to those of Asia or any part of the Old World. At Tule Springs, a radiocarbon date (22,000 B.C.) indicates a context in the early substages of the Wisconsin glaciation, but in other localities, such as the lowest levels of Danger Cave, Utah (*7*, pp. 193–195; *9*), or Fishbone Cave, Nevada (*7*, pp. 192–193; *10*), the assemblage can be no older than the final Wisconsin advance. Still other artifact assemblages that suggest an unspecialized food-gathering economy are not satisfactorily dated (*11*).

Pleistocene Big-Game Hunting

Sometime during the last Wisconsin interglacial era, or possibly even earlier, inhabitants of the North American continent entered upon a way of life that was based upon the pursuit and killing

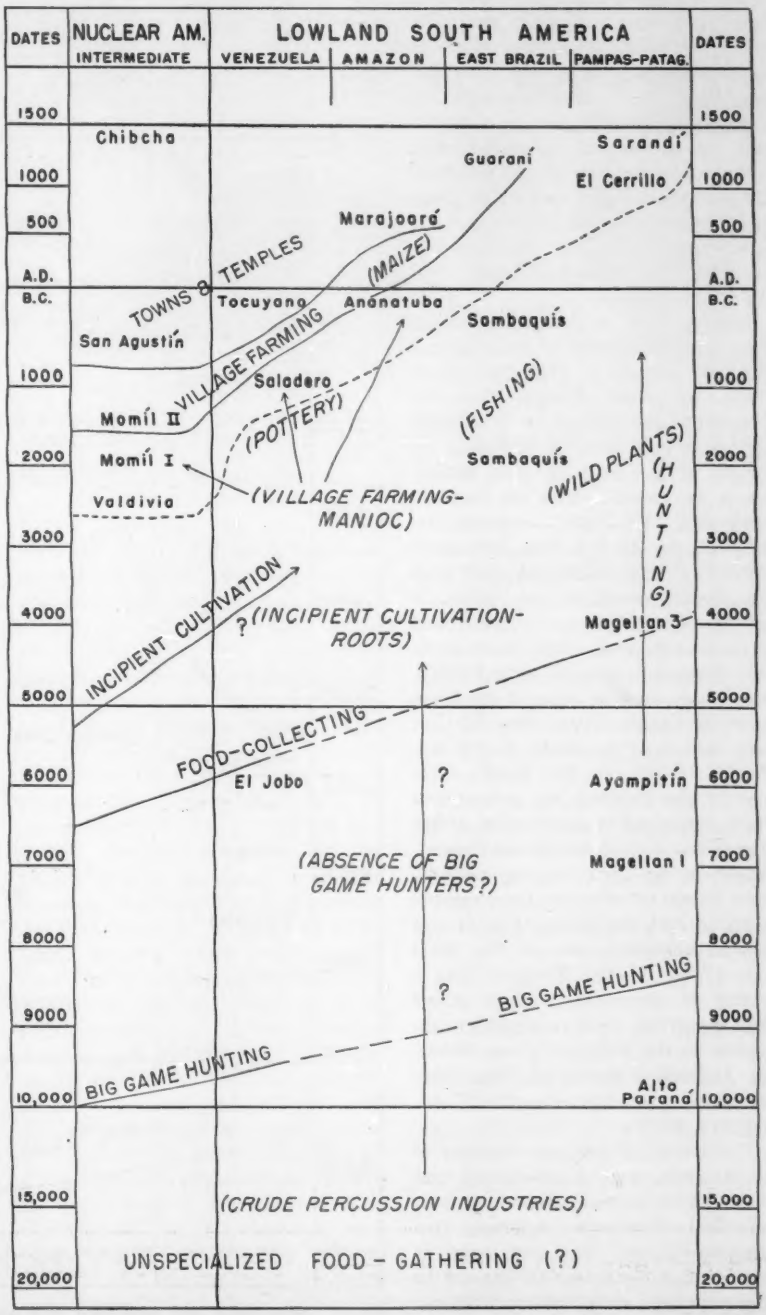

Fig. 2. Subsistence and settlement type levels in native America: cross section for Nuclear America and lowland South America. The first appearance of pottery is indicated by the dotted line.

of the great ice-age mammals, such as the mammoth, the mastodon, the camel, and later the buffalo. The origins of this life pattern are unknown. There are no visible antecedents in the possible earlier food-gathering cultures of the Americas. There is, it is true, a general correspondence between this New World specialized hunting of Pleistocene fauna and what was going on in the Old World in the approximately coeval upper Paleolithic stage; yet even this possibility of a connection with the Old World does not provide a reasonable source for the big-game-hunting complexes of the New World, with their distinctive and highly specialized equipment. Apparently the forms which are most indicative of the American big-game-hunting technology are New World inventions.

The technical equipment associated with big-game hunters in the Americas includes lanceolate projectile points shaped by pressure-flaking. These are frequently distinguished by a channel fluting on both faces of the blade. A variety of skin-scraping tools accompanies the points as they are found in camp sites, "kills," and butchering stations (*7*, pp. 23–90). The best documented of these discoveries come from the North American high plains in eastern New Mexico, Colorado, and Texas, and there are others from southern Arizona southward into Mexico. Some finds, such as those of the lower layer of Sandia Cave, New Mexico, may date back to before 15,000 B.C. (*7*, pp. 85–91; *12*). The Sandia complex is characterized by a lanceolate single-shouldered projectile point. Other discoveries, such as Clovis and Folsom, appear to be later, ranging perhaps, from 15,000 to 7000 B.C. The projectile points of both the Clovis (Fig. 4) and Folsom complexes are of the fluted form (*7*, pp. 23–84). There are also a variety of lanceolate, unfluted points that appear to mark a horizon subsequent to the Folsom. These include the Angostura, Scottsbluff, Plainview, and Eden types (see Fig. 2) (*7*, pp. 107, 118, 138).

The spread of big-game hunting in the Americas took place during, and in the first or second millennium after, the final Wisconsin substage, the Mankato-Valders. The total span of time of this dissemination appears to have been from about 9000 to 5000 B.C. Finds of fluted projectile points throughout the eastern woodlands of North America indicate the former prevalence

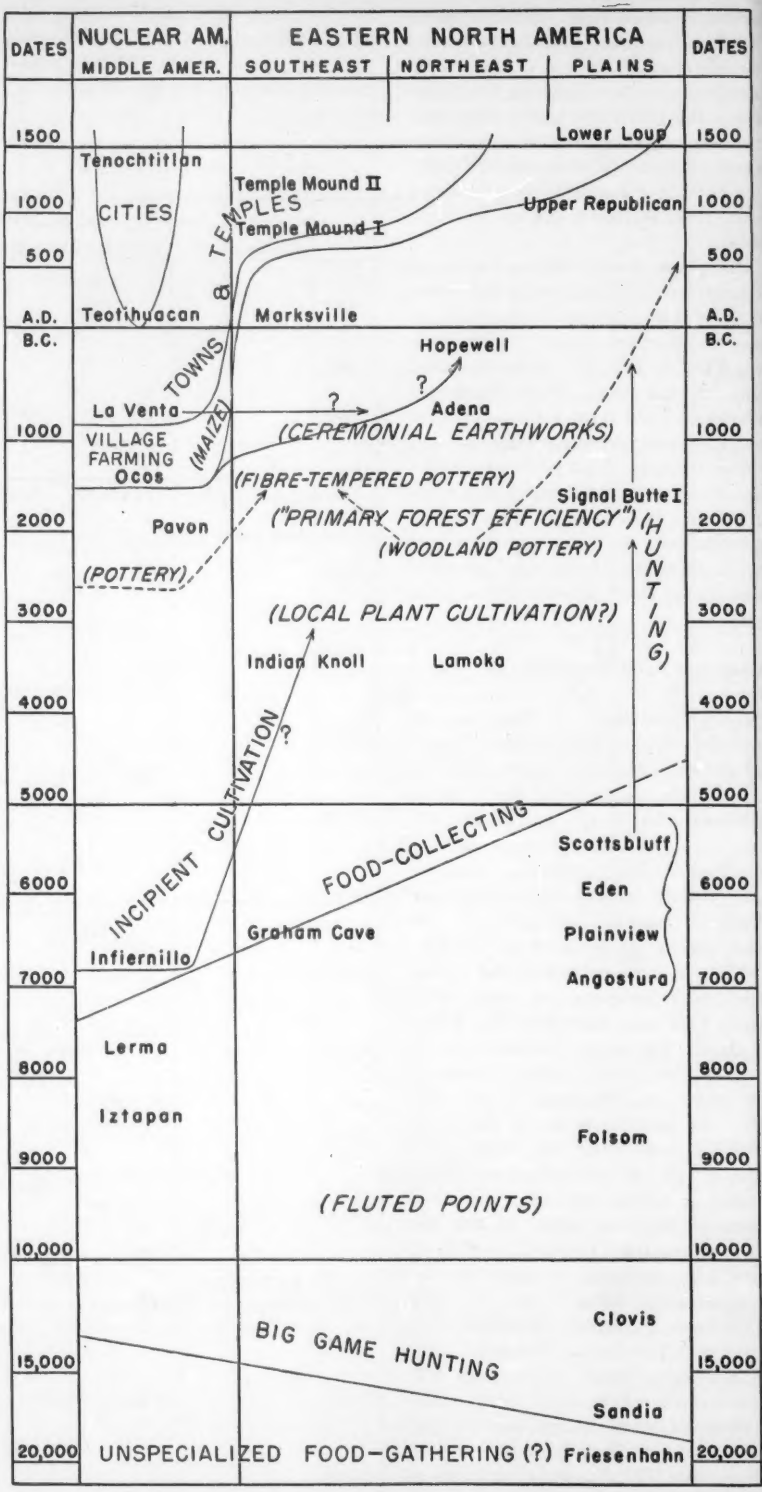

Fig. 3. Subsistence and settlement type levels in native America: cross section for Nuclear America and eastern North America. The first appearance of pottery is indicated by the dotted line.

of the pattern there (*13*). The Iztapan and Lerma remains in central and northeastern Mexico (*14*), the El Jobo points of Venezuela (*15*), the Aympitín industry of the Andes and southern South America (*16*), and the Magellan I culture of the Straits (*17*) give the geographical range of the early big-game-hunting societies.

The fate of the big-game-hunting pattern is better known than its beginnings. After 7000 B.C. and the glacial retreats, there was a shrinkage of the total territory in which the big herbivores could be hunted. The intermontane basins and the range country of western North America became more arid, and a similar climatic shift took place in southern South America. After 5000 B.C., with a still greater increase in warmth and dryness, big-game hunting persisted in the central zones of the old continental grasslands, such as the North American plains and the Argentine pampas. In these areas a modified hunting pattern, based, respectively, on the buffalo and the guanaco, continued into later times. Elsewhere, populations of hunters probably were forced into new environmental situations and new subsistence habits.

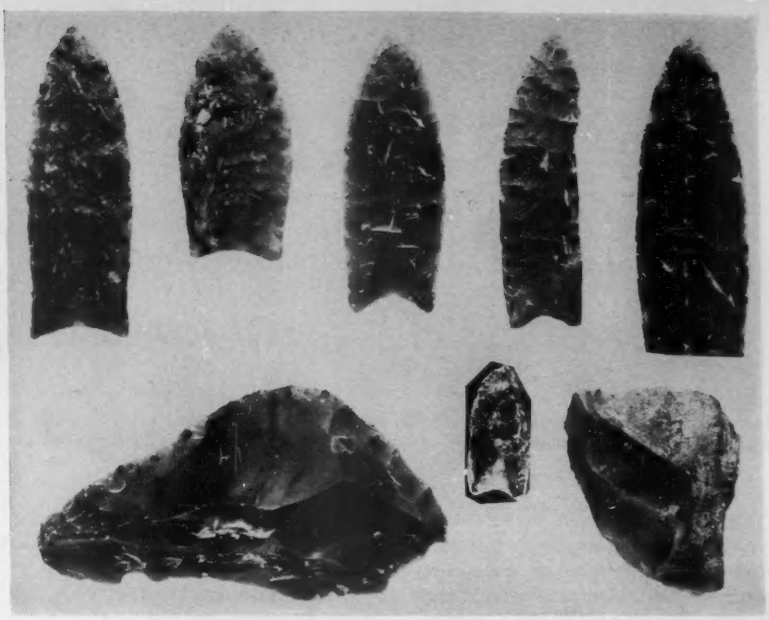

Fig. 4. Clovis type projectile points and associated scrapers from the Lehner site, southern Arizona. These artifacts are comparable to those found at the nearby Naco site. They are representative implements of the North American Pleistocene big-game hunters. [Courtesy Arizona State Museum]

Later Food Collecting and Hunting

These new subsistence patterns can best be described as food collecting. They are differentiated from the possible earlier food-gathering pattern in that they show specialization in the exploitation of regional environments and much more effective technological equipment. Although the taking of game is a means of subsistence in some of these patterns, it is not the old big-game hunting of the Pleistocene. The food collectors, for the most part, developed cultures of greater material wealth, larger communities, and more stable settlements than their predecessors. There were exceptions to this, particularly in areas or regions of severe natural limitations and in the earlier periods of the food-collecting patterns; but on the average, and certainly at the optimum, these generalizations hold true (*18*).

Chronologically, most of the food-collecting patterns had their beginnings in the span of time between about 6000 and 2000 B.C. There were, however, exceptions to this, as in the North American Great Basin, where the specialized collecting of wild seeds was well established as early as 7000 or even 8000 B.C. (*19*). As this is the same general area where clues to the most ancient food gatherers are found, it may be that there is a continuity in the Great Basin from the unspecialized gathering of the early Pleistocene to the later food collecting. According to this interpretation big-game hunting would be only partially represented or would be absent in an intervening sequence position (*20*). This relationship is expressed in Fig. 1.

This possibility of continuities between the North American desert food collectors and earlier resident cultures and populations brings attention to the larger question of the origins of the New World food-collecting patterns and peoples in general. There are three logical possibilities: (i) food-collecting societies and cultures were derivative, arising from the earlier food gatherers; (ii) members of such societies were the descendants of big-game hunters who were forced by the changing climatic conditions that followed the end of the Wisconsin glaciation to make readjustments; or (iii) they were more recent arrivals from the Old World by way of the Bering Strait. It seems quite likely that all three explanations may be useful, according to the particular geographical areas involved, and I have already mentioned the first two. The third explanation, that new arrivals from Asia played a part, is very probably correct insofar as the development of food-collecting cultures in northern North America is concerned. I have in mind particularly the northeastern woodlands, the northwest Pacific coast, and the subarctic and arctic. Elsewhere Asiatic influences were almost certainly of less direct account.

There are several major food-collecting patterns in the New World, and we can only skim over these very briefly. I have referred to what has been called a Desert pattern (*21*). The long depositional histories at Danger Cave, Utah (*9*), Leonard Rock Shelter, Nevada (*7*, pp. 190–192; *22*), and Fort Rock Cave, western Oregon (*7*, p. 184; *23*) are representative, and the basketry and crude milling stones found at these sites testify to a seed-collecting and seed-grinding subsistence. A similar story is recorded in the Cochise culture of southern Arizona-New Mexico (*24*), and there are evidences of this Desert pattern in Mexico as well (*25*).

In the woodlands of eastern North America there is another collecting pattern that shows an adaptation to forest and riverine conditions in hunting, utilization of wild plants, fishing, and catching shellfish. Such sites as the Graham Cave, in Missouri (*26*), suggest that

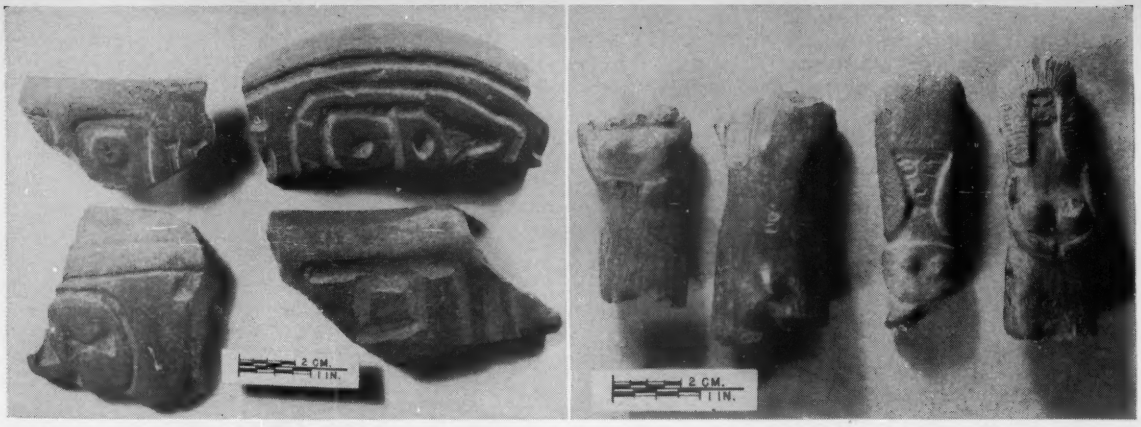

Fig. 5. Valdivia style pottery (left) and figurines (right) from coastal Ecuador. This excised ware and the crudely modeled female figurines may be among the earliest ceramic manufactures of the New World. [Courtesy Emilio Estrada]

there was a transition in the eastern woodlands area, at about 7000 B.C., from big-game hunting to food collecting. In the ensuing millennia these Eastern Woodland collecting cultures, subsumed under the name *Archaic* in much of the literature (*27*), underwent progressive adaptations to regional conditions. By 3000 B.C. they were characterized not only by rough grinding stones and specialized projectile points but by numerous items of polished stone, such as vessels, celts, weights for throwing sticks, and various ornamental or ceremonial objects. The Indian Knoll, Kentucky (*2*, p. 116; *28*), and Lamoka, New York (*2*, pp. 116–117; *29*), phases are typical of their particular regions. Many of the Archaic sites are huge heaps of shells situated along rivers or on the Atlantic coast. Such locations were undoubtedly suitable for a semisedentary, or even sedentary, existence.

Along the Pacific coast of North America there was another food-collecting pattern which paralleled in many ways that of the Eastern Woodlands. Here, by 2000 B.C. if not earlier, semisedentary societies based upon fishing and acorn gathering were established all along the coast from southern Alaska to southern California (*2*, pp. 133–137). In South America there were also ancient fishing societies along the coasts. The Quiani phase (*30*) of northern Chile displays this adjustment. On the Brazilian coast are the huge *sambaquis*, piles of shell refuse containing the skeletons and artifactual remains of food-collecting peoples who lived along these shores probably as much as two millennia before the beginning of the Christian Era (*31*). Coastal shell-mound dwellers are also known from Venezuela at about this same period (*32*, *33*).

I have mentioned that in both the North American and the South American plains there were retentions of big-game-hunting patterns into later times; even these cultures, however, show the result of contact with the neighboring food collectors in their possession of an increasing number of food-grinding implements. This is exemplified in the later North American Plains phases, such as the Signal Butte I (*34*), and by the later phases in the Strait of Magellan sequence and on the Argentine pampas (*35*).

Incipient Cultivation

The change from food collecting to a subsistence based upon plant cultivation was one of the great turning points in human prehistory. This is true of the New World as well as the Old, and there are indications in both hemispheres that this switch-over was not a rapid one, but that it was effected only over a period of experimentation. It is this era of experimental or incipient cultivation in the New World that I now wish to examine (*36*).

In the Americas it would appear that there may be at least four distinct and semi-independent traditions of incipient farming. Two of these are Nuclear American. The northern one, the probable propagator of maize, was located in Middle America and in the adjacent deserts of northern Mexico and the southwestern United States; the southern one had its focus on the Peruvian coast. A third incipient-cultivation tradition centered somewhere in the tropical forests of the Amazon or Orinoco. Its existence is difficult to demonstrate archeologically, but such a tradition is needed to explain the domestication of manioc and other root crops. A fourth, and distinctly lesser, tradition rose in eastern North America in the Mississippi Valley system.

The earliest evidence for incipient cultivation in any of these traditions comes from northern Nuclear America. The region is the northeastern periphery of Middle America, in the semiarid hill country of Tamaulipas. Here, preserved plant remains were taken from the refuse deposits of dry caves. In the Infiernillo phase, dating from 7000 to 5000 B.C., there are traces of domesticated squash *(Cucurbita pepo)* and of possible domesticates of peppers, gourds, and small beans. The cultural context is that of North American desert food collectors. There are, in addition to flint implements, net bags of yucca and maguey cords and woven baskets of a rod-foundation type. In the succeeding Ocampo phase, from about 5000 to 3000 B.C., beans were definitely domesticates. After this, between 3000 and 2000 B.C., a primitive small-eared maize came into the sequence in the La Perra and Flacco phases. R. S. MacNeish, who excavated and studied the Tamaulipas caves, has estimated the composition of food refuse of the La Perra phase to be as follows: 76 percent wild plants, 15 percent animals, and 9 percent cultigens. The La Perra and Flacco artifact inventories are not strikingly different from inventories of the earlier phases, although they demonstrate a somewhat greater variety of manufactures and an increased concern for

seed foods. A few centuries later, at about 1500 B.C., an archeological complex which is representative of fully settled village farming appears in the region. Thus, the Tamaulipas sequence offers a more or less unbroken story of the very slow transition from food collecting supplemented with incipient cultivation to the patterns of established cultivation (*37*).

Early and primitive maize is also found to the north of Tamaulipas, actually outside of Nuclear America, in New Mexico. At Bat Cave, corncobs from refuse of a Cochise-affiliated culture date between 3500 and 2500 B.C. (*38*). This is as early as the La Perra maize, or even earlier.

As yet, neither archeologists nor botanists have been able to determine the exact center of origin for domestication of maize in the New World, and it may be that this important event first took place in northern Middle America and in southwestern North America, where the intensive use of wild seeds in a food-collecting economy in a desert area provided a favorable setting. There remains, nevertheless, the very good possibility that a territory nearer the heart of Nuclear America and more centrally situated for the spread of maize in the hemisphere—an area such as southern Middle America—played this primary role in the cultivation of maize. The great difficulty is, of course, that the archeological record is so uneven, owing to the rarity of sites and environments where such things as plant remains are preserved in the earth. Such findings have not yet been reported in southern Middle America.

Coastal Peru, at the southern end of Nuclear America, provides a rainless climate and splendid conditions for preservation of organic materials in open archeological sites, and it is in Peru that we have glimpsed what appears to be a second tradition of incipient plant cultivation in Nuclear America. At Huaca Prieta, in a great hill of marine shells, sea-urchin spines, ash, and other debris, cultivated squash, peppers, gourds, cotton, and a local bean *(Canavalia)* were found, along with an abundance of wild root plants and fruits. The people who raised and gathered these crops and seafoods lived at Huaca Prieta at least 2000 years before the Christian Era. Whether there was, however indirectly, an exchange of domesticated plants between these early Peruvians and their contemporaries in Middle America is not certain. Such connections could have existed; or the

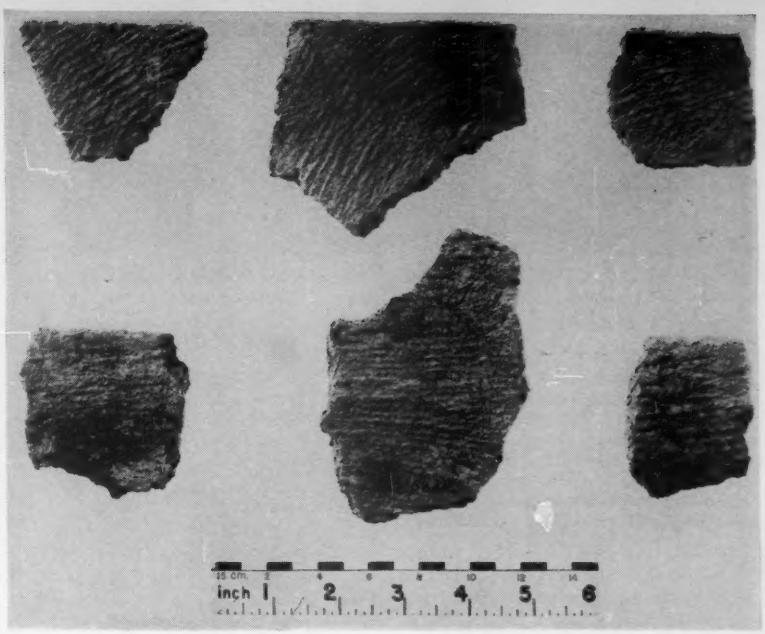

Fig. 6. Early Woodland pottery from New York State. Typical sherds of the Vinette I cord-marked ware, a ceramic that dates back 1000 B.C. or earlier. [Courtesy New York State Museum and Science Service]

beginnings of cultivation may have been truly independent of each other in these two areas of Nuclear America. Definite connections between early farmers of Middle America and of Peru appear, however, by 700 B.C. with the sudden presence of maize in Peru (*39*). This maize was not, like that at Bat Cave or in the La Perra culture of Tamaulipas, of an extremely primitive kind. It was brought, or it spread, to Peru as a relatively well-developed plant, and it serves as a link to Middle America. We may conclude that Nuclear America possessed, from this time forward, a single major horticultural tradition, but by this time we have also passed beyond the chronological limits of cultivation incipience.

An ancient tradition of plant cultivation in the South American tropical forest (*40*) is based upon the presumption that a long period of experimentation was necessary for the domestication of such tropical root crops as bitter and sweet manioc *(Manihot utilissima, M. Api)* and the yam *(Ipomoea batatas)*. It seems reasonably certain that these domesticates date back to before 1000 B.C. in lowland Venezuela. This is inferred from the presence of pottery griddles, of the sort used for cooking manioc cakes in later times, in the Saladero phase at the Orinoco Delta by this date (*32*). Also, the early archeological phase of Momíl I, in Caribbean Colombia, has the pottery manioc griddle (*41*). The dating of Momíl I is debatable, but some of the ceramic traits suggest a date as early as 2000 B.C. Saladero and Momíl I are, however, outside the chronological and developmental range of incipient cultivation patterns. They appear to be village sites based upon the cultivation of root crops, and as such they are comparable to, although historically separate from, village farming based on maize. I shall return to this point farther along. For the present I bring these sites into the discussion because their existence implies centuries, or even millennia, of prior incipient root-crop cultivation in tropical northern South America.

A fourth tradition of incipient cultivation for the New World derives from the cultivation of local plants in the Mississippi Valley by as early as 1000 B.C. These plants include the sunflower, the goosefoot *(Chenopodium)*, and the pumpkin *(Cucurbita pepo)* (*42*). This domestication may have been in response to stimuli from Middle America, or it may have been an entirely independent development. This Eastern Woodland incipient-cultivation tradition was undoubtedly but a minor part of the food-collecting economy for a long time. Just how important it ever became, or how important the early

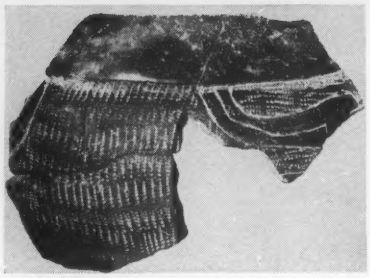

Fig. 7. Rocker-stamped pottery of the New World. (Top) Three rocker-stamped potsherds from the Turner site, Ohio Hopewell culture. (Right) Fragment of a zoned rocker-stamped bowl from an early level (about 800 B.C.) of the Barton Ramie site, British Honduras (Mayan territory). [Courtesy Peabody Museum, Harvard University]

diffusion of maize was to eastern United States cultures of the 1st millennium B.C., are crucial problems in the understanding of the area. I shall return to them later.

Appearance of Pottery

Before taking up the rise of village farming in Nuclear America and its subsequent spread to other parts of the hemisphere, let us review the first appearances of pottery in the New World. Obviously, the line indicating the presence of pottery on the charts is not comparable to the lines indicating type of subsistence or settlement (Figs. 1–3). American archeologists no longer consider pottery to be the inevitable concomitant of agricultural village life, as was the fashion some years ago. Still, ceramics, because of their very ubiquity and durability, are an important datum in many prehistoric sequences. Their presence, while not a necessary functional correlate of farming, at least implies a certain degree of cultural development and sedentary living.

At the present writing there seem to be two pottery traditions for native America. Curiously, the ages of these two pottery traditions—in the broadest sense of that term—may be about the same, 2500 B.C.

One of these pottery traditions, which we shall call the Nuclear American, is believed to be indigenous, but we can be no more specific about its geographic point of origin than to state that this is somewhere in the central latitudes of the New World. Actually, the earliest radiocarbon dates on the Nuclear American pottery tradition come from coastal Ecuador, in the Valdivia phase (Fig. 5), and are from about 2400 to 2500 B.C. (*43*). There are also early dates on pottery generally similar to that of Valdivia from Panama (about 2100 B.C.) (*44*, *45*). Thus, these earliest ceramic datings for Nuclear America are not from Middle America or Peru but from the Intermediate area, and this may be significant in following up origins, although the record is still too incomplete to say for sure. Both the Ecuadorean and the Panamanian early potteries are found in coastal shell-mound sites, and in connection with cultures about whose means of subsistence it is not easy to draw inferences, except to say that full village farming was unlikely. Possibly marine subsistence was supplemented with incipient cultivation, although we have no proof of this. The Valdivia and the Panamanian (Monagrillo) pottery is reasonably well made and fired, the forms are rather simple, and the vessels are decorated with incisions, excisions, punctations, and very simple band painting. These early Ecuadorean and Panamanian styles may be part of a stratum of ancient Nuclear American pottery that underlies both Middle America and Peru. There are some indications that this may be the case, although the oldest pottery so far known in the Middle American and Peruvian areas dates from several centuries later (*46*). In Fig. 1 the interpretation is offered that Nuclear American pottery is oldest in southern Middle America (for this there is as yet no evidence) and in the Intermediate area (for this there is evidence). Whatever the point of origin for pottery in Nuclear America, there is fairly general agreement that the ceramic ideas generated there carried to much of outlying North and South America.

The second major pottery tradition of the Americas is widely recognized by the term *Woodland*. Apparently not indigenous, but derived from northern Asia, it is best known from the eastern woodlands of New York and the Great Lakes region. So far, its presumed long trek from the arctic down through Canada has not been traced (*47*).

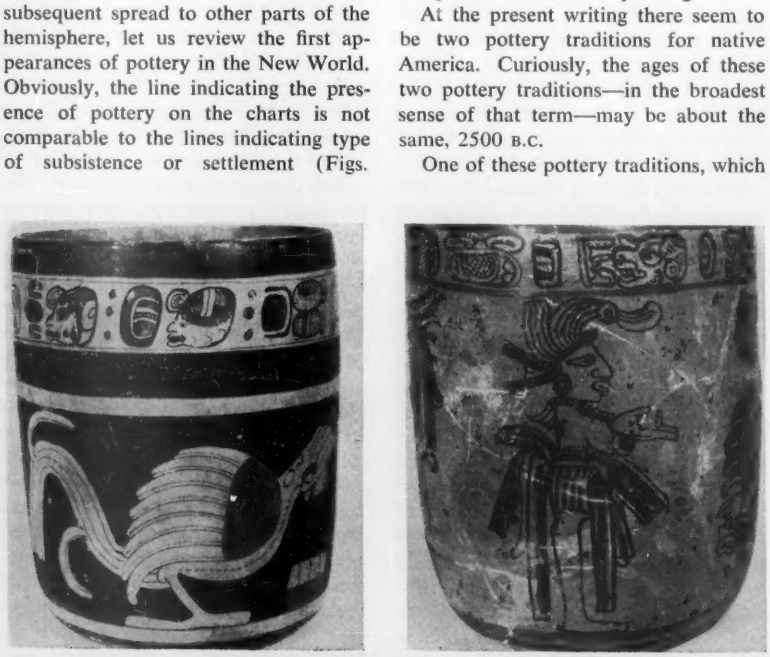

Fig. 8. Examples of fine Maya Classic polychrome pottery, perhaps the peak of native New World ceramic art. Note the bands of hieroglyphs used as decorative borders. [After J. M. Longyear III]

Woodland pottery is generally of simpler design than the early Nuclear American wares. Of an elongated form, it is frequently finished only with cord-marked surfaces (Fig. 6). As already noted, the oldest of this cord-marked pottery in the Americas may go back to 2500 B.C. (*48*). Even if this early dating is not accepted, there is little doubt but that Woodland pottery was well established in eastern North America before 1000 B.C.

In spite of the fact that the Nuclear American and Woodland pottery traditions are so radically different, there are, interestingly, a few similarities. The most notable of these is the technique of rocker-stamping combined with incised zoning of plain surface areas, known in Nuclear America and in the eastern United States (Fig. 7). The distinctive rocker-stamped treatment of pottery was accomplished by impressing the soft, unfired surface of a vessel with either a small straight-edged implement manipulated rocker-fashion or, possibly, with a fine-edged disk used like a roulette. The impressions left on the pottery may be either plain or dentate, and they always have a characteristic "zigzag" appearance. Rocker-stamping is found in the Valdivia phase in Ecuador, and it also occurs at about 1000 B.C. in parts of Middle America and in Peru (*49*). In eastern North America it is not found on the earliest Woodland pottery but is found on vessels which date from just a few centuries before the beginning of the Christian Era. Thus, the Nuclear American rather than the Woodland tradition has chronological priority in this trait in the New World (*50*). Again, as with so many other problems that perplex Americanists we can only refer to this without coming to any conclusions as to the timing and direction of the flows of possible diffusions. Nuclear American and Woodland ceramics may in some way be related, but at the present state of knowledge they appear to have different origins and substantially separate histories (Fig. 8).

Village Farming in Nuclear America

Braidwood and others have stressed the importance in the Old World of the threshold of the village-farming settled community (*1*, refs.; *51*). Although in its beginnings the agricultural village had a subsistence base that was no more adequate, if as ample, as that of some of the food-collecting communities, this base offered the potential in certain Old World localities that led, eventually, to civilization. In the New World a similar development was repeated in Nuclear America.

In the New World the line between incipient cultivation and village farming has been drawn at that theoretical point where village life is, in effect, sustained primarily by cultivated food plants (*52*). In archeology this distinction must be made by an appraisal of the size and stability of a settlement as well as by direct or indirect clues as to the existence of agriculture. In Nuclear America the earliest time for which we can postulate the conditions of village farming is the 2nd millennium B.C. For example, in Middle America in the Tamaulipas sequence the change-over from incipient cultivation to established cultivation takes place at about 1500 B.C. (*53*). Elsewhere in Middle America the known sequences begin with the village-farming stage, as at Early Zacatenco (*54*) (Valley of Mexico), Las Charcas (*55*) (Guatemalan Highlands), Ocos (*56*) (Pacific coast of Guatemala), and Mamom (*57*) (Maya lowlands) (*58*). In Peru the village-farming level is reasonably well defined with the appearance of maize in the Cupisnique phase and the shift of settlements back from the coast to the valley interiors. The date for this event is shortly after 1000 B.C. (*59*); this suggests that the horizon for village farming may have sloped upward in time from Middle America to Peru (Fig. 1). For the Intermediate area, where I have noted the earliest occurrence of pottery in Nuclear America, the threshold of village farming is difficult to spot. In Ecuador, the phases succeeding Valdivia have a different ecological setting, being inland in the river valleys rather than on the immediate shores (*60*). Perhaps, as in Peru, this correlates with the primary economic importance of plant cultivation. In Colombia, the Momíl II phase, which is represented by a stable village site area, is believed to have possessed maize (*41*).

The foregoing discussion carries the implication that village farming was a pattern diffused through Nuclear America from a single area or region. Essentially, this is the point of view expressed in this article. This is not to overlook the possibility that village agricultural stability may have arisen independently in more than one place in the New World. In fact, as I point out below, it apparently did just that in the tropical forests of South America. I am of the opinion, however, that in the Nuclear American zone the maize plant, genetically developed and economically successful, became the vital element in a village-farming way of life that subsequently spread as a complex. For the present, I would hazard the guess that this complex developed in southern Middle America and from there spread northward to Mexico and southward as far as Peru. This was, in a sense, its primary diffusion or spread. Afterward, there were secondary diffusions to other parts of the Americas.

The Village in Non-Nuclear America

These secondary disseminations of the Nuclear American pattern of village farming were responsible for the establishment of similar communities in

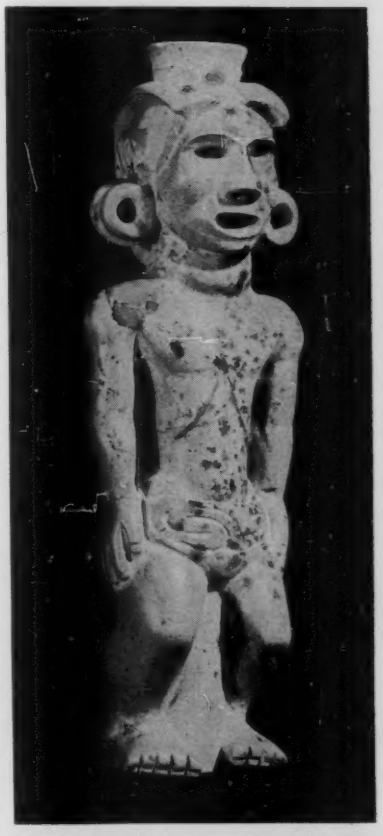

Fig. 9. Beautifully carved smoking pipe showing the skill with which the Adena craftsman worked small objects of stone. [Courtesy Ohio State Museum]

Fig. 10 (Left). A Mayan temple of the Classic period, about A.D. 300 to 900. This is the famed "Temple of the Inscriptions," at the important ceremonial center of Palenque, Chiapas, Mexico. Fig. 11 (Right). A palace-type structure at the Mayan ceremonial center of Sayil, Yucatan, Mexico. This handsome building, now largely in ruins, was built of rubble faced with cut limestone blocks and mortar. It is estimated to have contained about 100 rooms. It was probably constructed, at least in its final phases, between A.D. 600 and 900.

areas such as southwestern North America, the southern Andes, lowland tropical South America, and the eastern woodlands of North America (see Figs. 1–3). This process was relatively simple in southwestern North America and the southern Andes. The agricultural patterns were diffused to, or carried and superimposed upon, peoples with food-collecting economies of limited efficiency. In the Southwest, village farming and ceramics first appear at about the same time in such cultures as the Vahki, the Mogollon I, and the Basket-maker (*2*, pp. 151–155). This was between 200 B.C. and A.D. 300. Moving from the south, the village-farming pattern pushed as far as the Fremont culture (*61*) of the northern periphery of the Southwest. In the southern Andes there is, as yet, no good hint of an early incipient-cultivation tradition, and, apparently, pottery and agriculure arrive at about the same time, integrated as a village-farming complex. This flow of migration or diffusion was from Peru-Bolivia southward. Pichalo I (*30*) of northern Chile marks such an introduction, as do the earliest of the Barreales phases (*62*) in northwest Argentina. The time is about the beginning of the Christian Era. Beyond the southern Andes the village-farming pattern did not diffuse onto the plains of the pampas or Patagonia.

The relationship of Nuclear American village farming to the tropical lowlands of South America was much more complex. There the maize-farming pattern was projected into an area in which village life already existed. This is indicated in Fig. 2 by the entry "Village Farming–Manioc" in the columns headed "Venezuela" and "Amazon." Sedentary village life based upon root-crop farming is estimated to be as old as 2500 B.C. This is a guess, and, if it is correct, these villages are older than the Nuclear American village sustained by maize. Perhaps the estimated date is too early; however, at 2000 and 1000 B.C., respectively (see Fig. 2), we have the villages of Momíl I and Saladero, which, apparently, were supported by root-crop cultivation. It is of interest to note that Momíl I, near the mouth of the Sinú River in Colombia, lies within the axis of Nuclear America; yet it differs from the succeeding Momíl II phase at the same site in being oriented toward manioc rather than maize. This suggests that, in the Intermediate area at least, tropical-forest farming patterns may have preceded farming patterns for maize in Nuclear America.

Relationships between village farming in Nuclear America and in eastern North America are also complicated. It is unlikely that the local incipient-cultivation tradition in eastern North America ever matured into a subsistence pattern that could have supported fully sedentary village life. J. R. Caldwell (*63*) has argued that, in its place, a steadily increasing efficiency in forest collecting and hunting climaxed at about 2000 B.C. in a level of "Primary Forest Efficiency" (see Fig. 3). Such a level, he concludes, offered the same opportunities for population stability and cultural creativity in the eastern woodlands as were offered by village farming. While agreeing with Caldwell that the efflorescence of Adena-Hopewell (about 800 B.C. to A.D. 200) (*64*) (Fig. 9) is the brilliant end product of a mounting cultural intensity in eastern North America that originated in the food-collecting or Archaic societies, I am not yet convinced that plant cultivation did not play an important role in this terminal development. And by plant cultivation I am referring to maize, brought or diffused from Nuclear America. There is, as yet, no good direct evidence of maize associated with either the Adena (*42*) or the contemporary Poverty Point (*65*) culture. Maize is, however, found with Hopewellian cultures (*63*), although it has been assumed that it was of relatively little importance as subsistence at this time. I would argue that the riverine locations of Adena and Hopewell sites, together with the great size and plan of the ceremonial earthworks that mark many of them, make it difficult to infer an adequate subsistence if maize agriculture is ruled out.

To sum up briefly, the amazing cultural florescence of the Eastern Woodlands in the 1st millennium B.C. has not yet been satisfactorily explained. This florescence rests upon a chronologically deep series of Archaic food-collecting cultures which were at least semisedentary, and it contains elements, such as pottery, which are probably of Asiatic derivation and which added to the richness of the Archaic continuum. But the sudden burst of social and cultural energy which marks the Adena culture cannot be interpreted easily

without adding other factors to the equation, and perhaps these missing factors are maize agriculture and other stimuli from Middle America (see Fig. 3).

Village life is, of course, present in native America in the non-Nuclear areas under conditions where plant cultivation may be ruled out entirely. Settled villages developed on the northwest coast of North America, with population supported by the intensive food-collecting economy of the coast and rivers. The same is also true for the coast and interior valleys of California. It is significant, however, that in neither of these areas did aboriginal cultivation ever make much headway, while in eastern North America it became a staple of life in the later pre-Columbian centuries.

Temples, Towns, and Cities

In Nuclear America the town and eventually the city had beginnings in the settled farming village. A centralizing factor in this development was undoubtedly the temple. This earliest form of permanent structure usually had a flat-topped pyramidal mound of earth or rock as a base, and these mound bases of temples are found associated with some, but not all, of the village-farming cultures in Middle America (*66*). At first, the importance of such a mound, and of the temple that stood on it, was probably limited to the immediate village. Sometimes these villages were small, concentrated clusters of dwellings; in other instances the settlement pattern was a dispersed one, with a number of small, hamlet-like units scattered at varying distances from the temple center. Later on, the temple, or temple and palace structures, became the focal point of what might be called a town (*67*) (Figs. 10–12).

In Nuclear America the towns, like their antecedent villages, were either concentrated or dispersed. The former pattern developed in parts of Middle America, such as the Valley of Mexico or the Guatemalan Highlands, and in Peru; the latter was characteristic of the Veracruz-Tabasco lowlands or the Peten-Yucatan jungles of Middle America. In the towns the temple or ceremonial precinct was devoted to religious and governmental matters and to the housing of priests and of rulers and their retainers. The surrounding settlement zone, either scattered or concentrated, grew with increase in the numbers of farmers, artisans, or both. Trade was an important function of these towns.

In Nuclear America the town-and-temple community dates back to 800 B.C., a date that is applicable both to Middle America and to Peru. In the Intermediate area, between these two, town life was certainly pre-Columbian, but its date of origin is difficult to determine because there is a lack of adequate archeological chronologies (*68*).

In lowland South America, town-and temple communities also antedate the Conquest, and it seems likely that these communities were, in part, the result of contact with and stimulus from the Nuclear American axis (*69*). In the southern Andes the tightly planned clusters of rock and adobe buildings of the late archeological periods of northwestern Argentina reflect town and city life in Peru (Fig. 13) and Bolivia (*70*). Similarly, towns of the pre-

Fig. 12. A handsome masonry structure overlooking a plaza or courtyard. This building, resting upon an artificial terrace, is one of many at the Maya Classic period site of Copan in western Honduras. [Courtesy Carnegie Institution of Washington]

Fig. 13. A view of the great adobe wall bordering a side of one of the huge palace and living enclosures at the Peruvian north coast site of Chanchan. The ancient urban metropolis of Chanchan consists of several such enclosures. Chanchan was in its heyday in the 15th century, as the capital of the Chimu kingdom. It was taken over and destroyed by the Inca armies about A.D. 1470. [Courtesy Clifford Evans, Jr.]

historic southwestern United States relate to the Nuclear American zone. Development of these towns dates from sometime after A.D. 500, with an apogee in the Pueblo III and IV periods and in the Classic Hohokam phases (*71*).

On the other great periphery of Nuclear America, eastern North America, Middle American town life, with its temple mound-and-plaza complex, entered the Mississippi Valley sometime between A.D. 500 and 1000 and climaxed in the Mississippian or Temple Mound cultures shortly afterwards (*72*). Maize cultivation was an established part of this complex. Thus, in a sense, the thresholds of village farming and of the town-and-temple complex in the eastern woodlands, when these beginnings can be identified indisputably as of Nuclear American inspiration, are synchronous (Fig. 3).

There remains, however, as in our consideration of the village-farming level, the puzzle of the Adena-Hopewell cultures. As we have already noted, the Adena-Hopewell ceremonial mounds and earthworks, built between 800 B.C. and A.D. 200, are of impressive size. Some of them are comparable in dimensions, and in the amount of coordinated manpower necessary to build them, with the contemporary mounds of Middle America. Although the mounds of Middle America were usually temple platforms while the Adena-Hopewell tumuli were mounds heaped up to cover tombs and sacred buildings, this dichotomy should not be overstressed. Some mounds of Middle America also were tombs, or combined tombs and temples (*73*). In any event, it is safe to conclude that the Adena-Hopewell mounds were structures which memorialized social and religious traditions and served as community nuclei, as the ceremonial building did in Middle America. Was there a historical connection between Middle America and the Eastern Woodlands at this time, and was Adena-Hopewell ceremonial construction influenced by the emergence of the town-and-temple concept of Middle America? There is no satisfactory answer at present, but the possibilities cannot be dismissed (see Fig. 3).

In Nuclear America the city developed from the town and temple, and there is no sharp division between the two. Size is, assuredly, one criterion but not the only one. These cities were the nerve centers of civilizations. They were distinguished by great public buildings and the arts. Formal pantheons of deities were worshipped in the temples under the tutelage of organized priesthoods. Populations were divided into social classes. Trade, in both raw materials and luxury items, was carried on in these cities, and science and writing were under the patronage of the leaders (*74*). Not all of these criteria are known or can be inferred for any one city in the New World, but many of them do properly pertain to Middle American and Peruvian sites from as early as the first centuries of the Christian Era.

Cities in the New World seem to have been of two types, and these types may have their antecedents in the earlier dispersed and concentrated towns. The dispersed city, with its ceremonial center and outlying hamlets, appears to have been orthogenetic in its traditions and to have drawn upon, and commanded, a relatively limited geographical territory. The great lowland Mayan centers of the Classic period, such as Tikal or Palenque, are representative (*75*). The concentrated city adheres more to the concept of the city in the western European definition of the term. It was a truly urban agglomeration. Its traditions were heterogenetic, and its power extended over a relatively large territorial domain. The city was, in effect, the capital of an empire. Peruvian Chanchan, Aztec Tenochtitlan, and, probably, the more ancient Mexican city of Teotihuacan represent the type (*76*).

Although the cities and civilizations which developed in Middle America and Peru in the 1st millennium A.D. were unique and distinct entities in their own right, it is obvious that they also drew upon a common heritage of culture which had begun to be shared by all of Nuclear America at the level of village-farming life. This heritage was apparently built up over the centuries, through bonds of interchange and contact, direct and indirect. There are substantial archeological evidences in support of this supposition (*77*). During the era of city life these relationships continued, so that a kind of cosmopolitanism, resulting from trade, was just beginning to appear in Nuclear America in the last few centuries before Columbus.

In the outlands beyond Nuclear America, trade and influences from the cities followed old routes of contact and penetrated and were assimilated in varying degrees. In the south Andes there was the very direct impact of the Inca state in the final hundred years before the Spanish conquest (*70*), and northward from Mexico, Toltec-derived influences reached the North American Southwest in relatively unadulterated form (*78*). But, for the most part, the potentialities of the New World city for influencing and acculturating the "barbarian outlanders" were still unrealized when the Europeans entered the American continents.

Comments

Conclusions are inappropriate to a synthesis which, by its nature, is an outline of opinion, however tentative. Retrospective comment seems more in order.

A few things stand out. The early inhabitants of the New World were not remarkably different in their mode of life from the food gatherers and hunters of the Old World; yet even on these early horizons, and despite the relatively limited cultural inventories available, dissimilarities of form are striking. The interrelationships of the two hemispheres during the Pleistocene are still very vague.

Plant cultivation in the New World—its incipient rise and its culmination as the most effective subsistence base of the Americas—is, of course, analogous to happenings in the Old World. The important American plants, however, are of local origin. In the Western Hemisphere the incipience of cultivation followed the end of the Pleistocene, and was not a great deal later, perhaps, than in the Old World Middle East. Yet the period of incipience was longer here; over 5000 years elapsed before village life was sustained by crop cultivation. Is this because the first New World cultigens were inadequate as foodstuffs, and it was necessary to develop, first, the cereal maize before agriculture was made profitable?

Although there is a high correlation between village life and agricultural subsistence in the New World, there were New World societies and cultures which maintained villages without plant cultivation. In at least one instance, that of the ancient Adena-Hopewell development of eastern North America, community centers comparable to those of the contemporary farmers of Middle America may have been built and supported without a full-fledged farming subsistence.

I have slighted in this presentation the relationships between Asia and the Americas which were probably maintained from Pleistocene times down to the European conquest. This is particularly true of the cultures of the northern half of North America, where it is certain that there were contacts between the Old World and the arctic, subarctic, and northwest Pacific coasts. For Nuclear America nothing at all has been said of the possibility of trans-Pacific contacts between the Old World civilizations of China and Southeast Asia and those of Middle America and Peru. This undoubtedly reflects my own bias, but I remain willing to be convinced of such events and their importance to the history of culture in the New World.

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66. R. Wauchope [*Middle American Research Records* (Tulane University, New Orleans, La., 1950), vol. 1, No. 14] states the case for an early village-farming level without ceremonial mounds or constructions. While it is true that in some regions of Middle America the temple mound is absent in the earlier part of the "Formative" or "Preclassic" period, it is not clear that such a horizon prevails throughout all of Middle America. In fact, recent data [see M. D. Coe (*56*)] suggest that temple mounds were present in southern Middle America at the very beginnings of village farming.
67. See R. K. Beardsley, B. J. Meggers *et al.*, in "Seminars in Archaeology: 1955," *Soc. Am. Archaeol. Mem. No. 11* (1956), pp. 143-145, for discussion of an "advanced nuclear centered community."
68. It is possible that such a ceremonial center as San Agustín, in southern Colombia, was, in effect, a town with concentrated ceremonial components and, probably, scattered hamlet-sustaining populations. San Agustín has not been satisfactorily dated, but estimates have been made which would place it as comparable in age to town-temple centers in Middle America and Peru. See W. C. Bennett, "Archaeological Regions of Colombia: A Ceramic Survey," *Yale Univ. Publs. in Anthropol.* **30**, 109 (1944).
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74. See V. G. Childe's criteria of city life in *Town Planning Rev.* **21**, 3 (1950).
75. Such centers, although serving as foci for the achievements of civilization, continue more in the form and in the homogeneous traditions of the Beardsley, Meggers *et al.*, "advanced nuclear centered community" (*67*).
76. This kind of city, a "true" city in a modern western European sense, corresponds more closely to what Beardsley, Meggers *et al.* call "supra-nuclear integrated" communities (*67*, pp. 145-146).
77. See G. R. Willey, *Am. Anthropologist* **57**, 571 (1955), and in *New Interpretations of Aboriginal American Culture History* (Anthropological Society of Washington, Washington, D.C., 1955), pp. 28-45; see also, S. F. de Borhegyi, *Middle American Research Records* (Tulane University, New Orleans, La., 1959), vol. 2, No. 6.
78. Such features as Middle America-derived ballcourts and the casting of copper ornaments are well known in Hohokam archeology [see Wormington (*71*)].

The Great Fireball of 26 July 1938

A strongly hyperbolic orbit is derived for this body, indicating an origin outside the solar system.

Charles P. Olivier

At 9:02 P.M., E.S.T., on 26 July 1938, a great bolide or exploded fireball started over eastern Pennsylvania and, moving in a general northeast direction, ended over southern Vermont. It passed to the west of New York City, and its greatest brilliance, due to several explosions or flares, occurred to the north of that city; hence, comparatively few persons much to the south had their attention called to it. Further, few stars were readily visible, due both to the early hour and to scattered clouds or haze over some regions. Three persons at once began to gather data; C. A. Federer, then at the Hayden Planetarium, New York City; C. H. Smith at Waterloo, N.Y., who was the regional director for the American Meteor Society, and F. G. Watson at Harvard Observatory, Cambridge, Mass. All three began solutions based upon the data in their hands, and in fact Smith actually computed a preliminary atmospheric path, but after some time, as the number of reports was so great, all three men decided to send what was in their hands to me for a final solution. At an estimate, about 800 reports came in—far the largest number ever received by me on one fireball. Work was started, then delayed, and the same thing happened several times, but at last I have taken time to make as complete a solution as seems possible, and the results appear in this article.

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Finding the Path

The solution of paths and orbits of fireballs is of course of scientific interest and furnishes important data about our atmosphere and also enables one to form hypotheses dealing with their place and manner of origin. I have computed and published about 100 of them in the past, but for reasons to be

set forth, the fireball of 1938 has special significance because it appears quite certain that the body had a hyperbolic velocity and hence must have originated outside our solar system. As many of the greatest authorities in meteoric astronomy have expressed serious doubts about the possibility of fireballs coming from outer space, a full discussion of this case is justified. A parabolic orbit was also computed as a check, and every care was taken in deriving the apparent velocity.

From the immense number of reports, I had hoped that a very accurate path and orbit could be computed. But in computing the path of a fireball one is always handicapped by the fact that the object appears without warning; that most observers are untrained in estimating directions, angles, and time intervals; that many are in unfavorable locations and see but part of the path; and that a few are actually terrified. Also, many, despite carefully prepared questionnaires, are unable to fill them out intelligently, and a large percentage write pages without giving one useful fact. But all reports must be read by the computer and listed, and the useful data must be sifted from the useless. Hence, the task of dealing with some 800 reports is truly a very great one.

To compute the atmospheric path, the angular coordinates of both beginning and end points are needed. Altitudes and azimuths are usually given and can be directly employed; if positions among the stars are given (these are far more accurate if the person knows the constellations), it is necessary to turn the declinations and right ascensions into altitudes and azimuths before proceeding. Of course, the position of the observer and the time must be given. To obtain the velocity in the atmosphere, the duration must be estimated in seconds or fractions. Here the probable error will always be large. The physical aspects are also important: the color of the fireball, its stellar magnitude, whether it had flares or explosions along the path, and whether it had a train such as is sometimes left. This last is of special importance, for the drift of the train furnishes information about the winds in the upper atmosphere, mostly in the 104- to 80-kilometer level. These limits are for night trains; twilight and daylight trains are lower. However, most fireballs do not leave long-enduring trains.

For a solution, a map of the region is prepared on coordinate paper; the most convenient unit is 1 millimeter to 1 minute of latitude. It is necessary to compute the corresponding distances that the circles of longitude must be placed apart, but this is easy; simply multiply your unit by the cosine of the latitude. Then your map shows latitude circles as parallel straight lines; the longitude circles also straight but slightly converging. The positions of observers who have furnished angular coordinates must then be plotted. It is obvious that this is a tedious matter, but it is necessary for the best solution. If all stations are within one state, an automobile map serves almost as well, but when the area is larger, distortions of azimuth lines will probably occur. Upon the map, the observed azimuth lines are then plotted; however, the longitude circles are used for the protractor, not the latitude circles, as on such a map, except for the central meridian, the circles do not intersect exactly at right angles, though the difference is very small.

Were the observations perfect, all azimuth lines for the sub-beginning point B_1 would intersect in a point; the same would be true for the sub-end point, E_1. In practice, we find the wildest deviations, due both to poor estimates and to the observers' not seeing the real ends of the path but intermediate points.

The computer then has to decide where within this area is the point in question. Each case has to be settled on its merits, so no rigid rule can be given. But it is obvious that more weight must be given to reports which indicate that the observer has some knowledge of the heavens and to those from observers who use a compass or other mechanical aids, to determine directions. But even here we often run into a difficulty as to the compass directions, for many forget to tell whether the local deviation has been allowed for. Since the deviation is often greater than 10°, this is serious.

Path through the Atmosphere

The azimuth of the path of the 1938 fireball could be found with considerable certainty because, to ten observers in New Jersey or west of New York City, the path appeared vertical; this meant they were in its plane. This permitted a much better selection of the subpoints B_1 and E_1 than could have been made otherwise. These two points having been chosen, the heights, as determined by each observer, could be determined by measuring his distance from the two points and multiplying by the tangent of the altitude, with curvature correction added to the observed altitude. This correction is nearly one half the

Table 1. Data on the atmospheric path and orbit (American Meteor Society No. 2279). The calculations were carried out with four-place logarithms to minutes of arc.

Date	1938, July 26.88 G.M.T. (26 July, 9:02 P.M., E.S.T.)	
Sidereal time at B	261° 54′	
Began over B_1	$\lambda = 75° 44'$; $\phi = 40°\ 0'$ at 69 km	
Point over C_1	$\lambda = 74° 34'$; $\phi = 41° 20'$ at 60 km	
End over E_1	$\lambda = 72° 42'$; $\phi = 43° 18'$ at 45 km	
Projected length of B_1E_1	441 km	
Projected length of C_1E_1	258 km	
Length of BE	443 km	
Length of CE	260 km	
Duration for CE	9.71 sec	
Velocity over CE, observed (W)	26.8 km/sec	
Velocity over CE, geocentric (u)	24.5 km/sec	
Orbital velocity, parabolic (v)	41.4 km/sec	
Orbital velocity, hyperbolic (v)	52.7 km/sec	
Radiant uncorrected	$a = 34.5°$; $h = 3.3°$	
Curvature correction	$+ 1.2°$	
Atmospheric path		
Zenith correction, parabolic		15.6°
Zenith correction, hyperbolic		−5.0°
Radiant P (parabolic)	$a = 34.5°$; $h = -11.2°$	
Radiant H (hyperbolic)	$a = 34.5°$; $h = -0.6°$	
Radiant P	$\alpha = 208.6°$; $\delta = -46.2°$	
Radiant H	$\alpha = 216.5°$; $\delta = -37.3°$	
Radiant P	$\lambda = 224.2°$; $\beta = -32.0°$	
Radiant H	$\lambda = 226.6°$; $\beta = -21.6°$	
Heliocentric orbit	*Parabolic*	*Hyperbolic*
Semimajor axis	∞	0.86 A.U.
Eccentricity	1.00	2.17
Perihelion distance	1.012 A.U.	1.007 A.U.
Longitude ascending node	303.5°	303.5°
Longitude perihelion	310.5°	311.5°
Inclination	10.5°	10°

distance measured in minutes of arc—one good reason why that was chosen as the unit for our chart. However, many reports indicated that the first and last point seen by the observer were far from the true ends. Hence, a vertical diagram was drawn, with the projected path horizontal, and points where the separate azimuth lines cut this path were determined, and then the heights of the points on the path were calculated in same manner. In this way, not only are the end points B and E shown on the diagram, but many intermediate points are shown as well. The computer draws a line which will best satisfy all these points, as a wide scatter from a straight line must be expected.

There was an added fact which helped greatly in determining the slope of the true path: 28 observers in New England saw the path parallel to the horizon or with a very small slope. By knowing the distance of these observers from the sub-points, or knowing where their azimuth lines cut the projected path, it is quite possible to calculate the true slope, once we have calculated the end height E_1E, which is almost always more readily determined. These determinations were added to the chart, and the atmospheric path arrived at was based upon all the data mentioned. As a result, much confidence can be had in the calculated direction of motion of the fireball, and, when this is corrected for curvature it gives at once the position of the apparent radiant in the sky. From the paucity of observations of the exact beginning point B, this point is known with far less certainty, and hence knowledge of the length of the path also suffers. Again, however, we were fortunate in that most observers near New York City did not see the fireball until it was past the west point, and under or near Ursa Major. Since they used stars in this constellation as references, we were able to determine an intermediate point C_1, which is much better known than B_1, the true sub-beginning point. In fact, the distance C_1E_1 is the projection of the path as seen by the majority of the observers, particularly of those who gave estimates of duration. Hence, it seems wise to use CE instead of BE in determining the observed velocity. This, incidentally, gives a minimum value for the latter, a point of great importance as will be seen later. The adopted C_1C is based upon 39 reports, E_1E upon 41.

There were 183 duration estimates in all. As those under 4.0 seconds were obviously too small and the six over 43 seconds were much too long, we used 145, which gave the mean as 9.71 seconds. This gives an observed velocity of 26.8 km/sec. When corrected for the earth's attraction, this value drops to 24.5 km/sec, the true geocentric velocity.

The fireball did not leave an enduring train, but it did flare up or burst at least four times. Doubtless many of the discrepancies in the reports arose from observers' taking the last bursting point as the true end point. There is no doubt but that the fireball showed a definite disk to observers who were anywhere near the path; estimates of the diameter ran from 3 to 30 minutes of arc, or the diameter of the moon. It was also very brilliant, growing in brightness at each flare, though it is almost impossible to give a definite figure in stellar magnitudes. The color was reported by several hundred observers; it was probably blue-white for most of its path, reddish near the end, but this latter observation may be due to most observers' having seen it then at a greater distance and a lower altitude. Some report a slight curving after the last explosion, but it is impossible to allow for this in computing. Fragments or sparks certainly fell near the end. Its considerable height and rather large velocity make it improbable that it furnished any meteorites. Data on path and orbit are given in Table 1.

In further considering the observed velocity, which helps so greatly in determining the true heliocentric velocity, we find that the approximate deviation from the 9.71 seconds adopted for the duration is $\pm$ 4.4 seconds. A rough approximation for u, the geocentric velocity, when parabolic velocity is assumed, gives about 10 km/sec. This is two and one-half times smaller than the derived value. Even were we to add the 4.4 to the 9.71 seconds, this would make w, the observed velocity we use, still 18 + km/sec, and u about 2 km/sec less. As for the duration, 33 of the reported values are within less than 1.0 second of the 9.71 seconds adopted, and of all the 145, 3 to 2 are smaller than 9.71. Also, if it were assumed that the whole path BE was observed by all 145 observers, this would give us a far greater velocity; hence, the assumption that CE was the part of the path observed by the average observer tends to lessen the velocity, though it is known that some saw more—and of course some must have seen less.

In conclusion, there seems no reasonable doubt that in this case we had a fireball with a large hyperbolic velocity. While I have computed other orbits with the same implications, never before have the data been so numerous and so decisive (*1*).

Note

1. This work would have been impossible but for the time and trouble spent by the three workers mentioned in the opening paragraph, who collected and partly digested the data. I am most grateful to them and also to the many hundreds of observers who reported.

Science in the News

Annual Awards for Outstanding Research Presented at AAAS Meeting in Chicago

The following awards for outstanding work in various fields of science were presented during the annual AAAS meeting, which took place in Chicago 26–31 December.

Rosenthal Award. Wilhelm C. Hueper, chief, Environmental Cancer Section, National Cancer Institute, Bethesda, Md., received the AAAS–Anne Frankel Rosenthal Memorial Award for Cancer Research for his study of the causes of cancer in man. The $1000 award is provided by the Richard and Hinda Rosenthal Foundation and was given for the fifth time.

Since the early 1920's when his scientific career began, Hueper has been engaged in research on exogenous causes of human cancers, such as lung cancers from air pollutants, skin cancers from arsenicals, and cancers of the breast from the cosmetic injection of paraffin. Through a critical evaluation of various morphologic characteristics of cancers of the uterus and breast, which resulted in development of the "histologic malignancy index," he attempted to prognosticate the growth and spread tendencies of cancers and thereby aid the clinician in the selection of proper therapeutic measures.

During the next decade Hueper conducted investigations on immunologic aspects of leukemia and on the experimental production of leukemia in mice by the administration of small doses of x-rays. He was one of the first to call attention to the possibility that such irradiation constituted a cancer hazard.

In 1938, in association with F. H. Wiley and H. D. Wolfe, Hueper succeeded in producing, by feeding β-naphthylamine to dogs, bladder cancers similar to those seen in workers associated with the manufacture of certain dye intermediates (β-naphthylamine, benzidine), rubber antioxidants (4-aminodiphenyl), and synthetic aniline dyes. In subsequent experiments he showed that a urinary metabolite of β-naphthylamine—namely, 2-amino-*l*-naphthol — possesses cancer-producing properties for mice. These observations opened a large new field for experimental study and pointed the way for subsequent investigations on species-specific metabolic mechanisms which seem to control the susceptibility of different species to the carcinogenic action of various aromatic amines and their metabolites.

In 1942 Hueper published *Occupational Tumors and Allied Diseases*, which has become a standard text on this subject. This book provided comprehensive information on the various types and the growing number of occupational carcinogens and on the cancers produced by them in industrial workers and called attention to the spread of these carcinogens in the human environment.

In this period Hueper's previous intermittent work on spontaneous and occupational arteriosclerosis crystallized in a systematic experimental attack on the etiologic factors and causal mechanism responsible for degenerative vascular diseases, culminating in the development of the "anoxemia theory of arteriosclerosis." Of special importance in these investigations were his studies on disturbances of the plasmatic colloidal equilibrium as significant causal mechanisms in atherosclerosis. This concept was developed from observations on experimental atherosclerosis elicited by the injection of a series of synthetic, macromolecular polymers used in medicine and industry as plasma substitutes, resins, plastics, and films.

With his appointment to the National Cancer Institute and the creation of the Environmental Cancer Section in 1948, Hueper returned to studying various problems of environmental and industrial carcinogenesis, particularly the possible cancer hazards of exposure to various metals (arsenic, uranium, chromium, and nickel). Other phases of these investigations covered possible cancer hazards from air pollutants, water pollutants, petroleum derivatives, synthetic hydrogenated coal oils, food additives and contaminants, and plastics. In experimental studies on rats, mice, and dogs conducted, in part, in association with William Payne, Hueper succeeded in demonstrating that chromium is a powerful carcinogen and that the relative carcinogenic potency of various chromium compounds depends on the degree to which they are soluble in water—that is, their degree of biologic availability. As a result of these observations, chromate- and chromium-compound-producing industries are now in a better position to institute rational and effective measures for protecting their workers against the hazards of occupational lung cancer.

Theobald Smith Award. William F. Scherer, professor of bacteriology and immunology, University of Minnesota Medical School, Minneapolis, Minn., received the Association's 15th Theobald Smith Award in Medical Sciences. The award, which is supported by Eli Lilly and Company, consists of $1000, a bronze medal, all travel expenses to and from the meeting, and all expenses at the meeting for its duration. It is given for "demonstrated research in the field of medical sciences, taking into consideration independence of thought and originality." The recipient must be less than 35 years of age as of 1 January of the year in which the award is made, and must be a U.S. citizen.

In 1952, Scherer published a series of papers on the propagation in vitro of poliomyelitis viruses. The series established that poliovirus could be grown in vitro in extraneural tissues (human and monkey testicles). He also characterized the growth of the virus and its accompanying cytopathology.

Subsequently he engaged in research on a pure strain of mammalian cells (Earle, the L strain) for the cultivation of viruses in vitro. Using the principles evolved in this study, Scherer then employed HeLa cell cultures in the assay of poliovirus and of poliovirus antibodies and for rapid isolation and identification of poliovirus from human beings. In reporting the first important application of cell dispersal with trypsin (Rous-Jones), Scherer made quantitative studies in a monolayer on glass possible. The result has been the development since 1953 of cell-culture techniques for virus-plaque counts, cell-plate counts, and mass production of mammalian cells for the production and assay of virus. Morphologically and culturally stable lines of human and other mam-

malian cells in continuous culture are now being employed widely; the complex phenomenon of animal virus infection is reduced to a simpler in vitro system in which chemical and physical factors can be altered at will.

Studies on the ecology of Japanese encephalitis were designed to investigate each of the known natural hosts (mosquitoes, birds, swine, rodents, and human beings) of the encephalitis virus. Only one mosquito species was consistently infected by the virus naturally: the *Culex tritaeniorhynchus*. In this species it was found that the time of infection was independent of the total population, and that the incidence of mosquito infection increased while the total population declined. This emphasized that there is no direct chronological relationship between peak vector populations and epidemics or epizootics, but rather that vertebrate infection is related to the time of maximal density of infected mosquitoes in an area. It was found that the vector mosquito tended to bite certain animals and birds more often than others, and more often than it bit man; however not all mosquitoes behaved like the vector.

The epidemiologic sequence of infections by Japanese encephalitis virus was found to involve a vector (mosquito), amplifying agents (birds and swine), and diseased hosts (men and horses). The natural infection cycle could be divided into periods of preemergence, virus dissemination, and declination to eclipse.

Campbell Award. Charles M. Rick, University of California, Davis, received the AAAS–Campbell Award for Vegetable Research. Established 2 years ago by the Campbell Soup Company, the award consists of $1500 and a bronze medal. (Travel expenses for the recipient to attend the AAAS meetings and to receive the award in person are paid, in addition.) The award is given for an outstanding single research contribution, of either fundamental or practical significance, concerning the production of vegetables, including mushrooms, for processing purposes. Emphasis is on basic research and on applications concerned with vegetable production rather than crop utilization or crop processing. The one or more papers reporting this single research must have been published—or accepted for publication—in a recognized scientific journal not more than 2 years prior to the date of granting the award, which is open to all residents of the United States and Canada. A panel of seven judges representing all areas of plant science determines the winner or winners of the award.

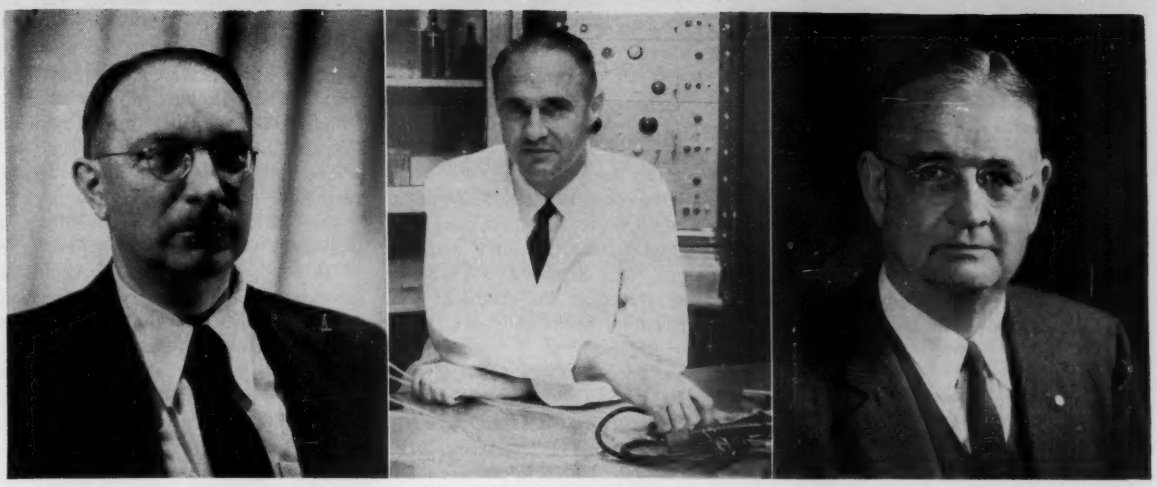
In his work Rick presents new evidence of the frequent hybridization between plants of the cultivated tomato (*Lycopersicon esculentum*) in Ecuador, Peru, and northern Chile.

Although the garden tomato is very highly self-pollinated in most regions of cultivation, it cross-pollinates freely in the range of its wild relatives—Ecuador, Peru, and northern Chile. Cohabitation of garden tomatoes and an intercompatible species in this region permits extensive gene exchange between them. These factors lead to a high level of variability and promote rapid evolution of new forms.

Direct genetic tests revealed rates of natural cross-pollination as high as 25 percent—levels vastly higher than those in other regions of cultivation. Frequent hybridization is also reflected in the variation of progenies from single plants collected in various parts of this region. More than half of these progenies segregated for monogenic traits, and a corresponding variability was observed for quantitative traits. The coextensive distribution of the cultivated tomato (*L. esculentum*) and the wild currant tomato (*L. pimpinellifolium*) in this region and the appearance of traits of the latter in cultivated tomatoes render it likely that part of the observed variability results from introgression of traits from the wild-currant forms. Rick found similar evidence for introgression of *L. esculentum* traits into *L. pimpinellifolium*.

Since both species are frequently used as sources of valuable germ plasm for breeding purposes, these results point up the need for coping with high variability, found even within single-plant progenies in contrast to the pure-line uniformity usually found in tomatoes. Rick's studies also have a bearing on the origin of the cultivated common varieties. In keeping with previous conclusions that domestication probably took place in southern Mexico, he points out that the present array of cultivated tomatoes in western South America could have evolved from early post-Columbian introductions in view of the rapid rate of reproduction, prevailing self-pollination, and frequent outcrossing, particularly to the wild-currant form. His findings are also significant in relation to the systematics of the two species.

John A. King of Armour and Company (left) and H. E. Robinson of Swift and Company (right), who accepted the Industrial Science Award for their companies.



(Left) Wilhelm C. Hueper, winner of Rosenthal Award. [National Institutes of Health] (Middle) Arthur C. Guyton, winner of Gould Award. (Right) Charles S. Draper, winner of the William Procter Prize. [Fabian Bachrach]

The cultivated tomato is almost exclusively self-pollinated. Such intensive inbreeding renders it remarkably uniform; in fact, most modern horticultural varieties are effectively pure lines or populations of several very closely related pure lines. The native region in western South America is therefore of considerable interest because of its much higher rates of natural cross-pollination.

In a random sample of 18 spontaneous seedling mutants, linkages were found by Rick for 15, of which 6 are located on chromosome 2. According to binomial tests, this distribution is nonrandom. Even within chromosomes the distribution appears irregular, as indicated by his finding a cluster of three dominant genes on chromosome 2. Such concentration is unusual in view of the rarity of spontaneous dominant mutations.

These findings correspond with the results of research on the linkages of other gene samples and with the distribution of all known linked genes. For various reasons the deviation probably does not result from the use of favorably located marker genes or from the presence of duplicated segments but reflects greater physical length and, especially, higher genetic activity of chromosome 2. With a net effect of reducing the chromosome number and increasing the probability of linkages, such nonrandom distribution has serious consequences for the use of tomatoes in genetic and breeding investigations. The transfer from one genotype to another of several polygenes without shifting many adjacent genes is rendered more difficult.

Gould Award. Arthur C. Guyton, professor and chairman of the depart-

(Left) William F. Scherer, winner of the Theobald Smith Award. (Middle) Charles M. Rick, winner of the Campbell Award. (Right) Stanley Schachter, winner of the Socio-Psychological Prize.

ment of physiology and biophysics, University of Mississippi, Jackson, received the AAAS–Ida B. Gould Memorial Award for Research on Cardiovascular Problems. The $1000 award is provided by the Richard and Hinda Rosenthal Foundation and was given for the fourth time at this year's meeting.

Guyton invented instruments for making precise measurements in the study of respiratory and circulatory systems. These instruments include electronic devices for determining pressures, volumes, and flows in the heart and lungs and in the peripheral circulation. Out of investigations with these instruments have come new ideas concerning the way in which circulation of the blood is regulated.

Industrial Science Award. Armour and Company and Swift and Company were corecipients of the AAAS Industrial Science Achievement Award, which is administered by Section P (Industrial Science). The award is made annually to a company or companies that develop significant practical applications of basic scientific discoveries.

In accepting the citation for Armour and Company, John A. King, director of research of that organization, said: "Early in Armour's history, the meat packer confined his operations almost entirely to edible products. When the disposal of waste products became more and more of a problem, Armour saw an opportunity to convert millions of pounds of such materials into valuable commercial items and turned to science for the means of doing this."

In accepting the citation for Swift and Company, H. E. Robinson, vice president for research, described some recent company achievements. He said: "The use of our four-point program to control staphylococcus organisms in hospitals will be a major benefit to the medical profession. The utilization of electrical stunning of hogs represents a major contribution toward humane slaughter of livestock. Our continuous chilling technique for poultry is another example of the application of basic scientific principles to our operations."

Socio-Psychological Prize. Stanley Schachter, of the department of psychology and the laboratory for research in social sciences, University of Minnesota, received the AAAS–Socio-Psychological Prize. The basis for the award is Schachter's most recent book, *The Psychology of Affiliation*. Published in 1959 by the Stanford University Press, the work reports experimental studies of the circumstances that drive men to seek each other out and the circumstances that cause men to seek privacy. Schachter considers the ways in which emotion and anxiety affect social needs, and he examines social behavior under such conditions as hunger, isolation, and fear of pain.

Schachter's early research was concerned with problems in communication and social influence, affiliative behavior, cross-cultural research, and sensory psychology. His interests at present are concentrated in the study of the physiological and social determinants of emotional states.

William Procter Prize. Charles S. Draper, head, department of aeronautical engineering, Massachusetts Institute of Technology, received the William Procter Prize for scientific achievement, which is awarded annually by the Scientific Research Society of America.

Criminology Award. Archbishop Bernard J. Sheil of the Chicago Archdiocese received an annual award offered by the American Society of Criminology, which is an affiliate of the AAAS. The award was for Sheil's 50 years of work in the field of criminology. After serving in his youth as a jail chaplain, Sheil founded the Catholic Youth Organization as a major bastion against juvenile delinquency. His leadership in the fight against racial and religious intolerance and prejudice, culminated in his acceptance of the chairmanship of the Illinois Committee to Abolish Capital Punishment.

The winner of the 32nd AAAS–Newcomb Cleveland Prize will not be announced until next March. The $1000 award is for an outstanding paper delivered at the annual meeting. The 1959 winner will be honored at the 1960 AAAS meeting in Philadelphia next December.

Defense Education Act Aids Study of Foreign Languages

Thirty-five modern foreign language institutes for the training of 2000 elementary- and secondary-school language teachers will be established at colleges and universities next summer. Authorized under Title VI of the National Defense Education Act, the language institutes provide professional training to elementary and secondary school teachers of French, German, Italian, Russian, and Spanish.

With three exceptions, none of the institutes will accept teachers who attended one of the 12 institutes conducted last summer. The three institutes which will give preference to those who have already attended an institute include Hollins College for teachers of French, University of Puerto Rico for teachers of Spanish, and Stanford University for teachers of German.

The institute sponsored by Stanford University will be the only one of the 35 to be conducted abroad. About 85 secondary-school teachers of German will spend 9 weeks at the institute to be located at Stuttgart, Germany. It is regarded as a pilot enterprise, and from this experiment the Office of Education will be able to determine whether a limited number of institutes may effectively be established in foreign countries.

Two institutes have been designed for elementary-school language teachers. They will be conducted at the University of Kansas for teachers of German and Spanish and at Tufts University for teachers of French and Spanish. Twenty-five institutes will enroll secondary-school teachers, and the remaining eight institutes will enroll both elementary- and secondary-school teachers.

Teachers from public schools who attend the institutes receive stipends of $75 a week and an allowance of $15 a week for each dependent. Private-school teachers attend the institutes without charge but receive no stipends. School teachers interested in attending an institute should write to the institute director, not to the Office of Education.

Graduate Studies Also Aided

Under Title VI of the National Defense Education Act, the U.S. Office of Education will also award nearly 400 Modern Foreign Language Fellowships. The purpose of these fellowships, for graduate study during the summer of 1960 and the 1960–61 academic year, is to increase the number of teachers of 85 foreign languages seldom taught in the United States—languages spoken by millions of people throughout the world.

First preference in awarding fellowships will be given to students studying Arabic, Chinese, Hindi, Japanese, Portuguese, Russian, and Urdu. Candidates for the language fellowships should apply to universities offering advanced training in any of the 85 languages for which the Commissioner of Education has declared there is a national need. Graduate schools offering these languages have been asked

by the Office of Education to set up committees to review fellowship applications and to make recommendations to the Office. The deadline for receipt of applications from the graduate schools is 15 February 1960, and awards will be made before 30 April 1960.

Fellowships will carry stipends ranging up to $2700, plus tuition and fees. The graduate fellow will receive travel allowances and allowances for dependents.

History of Science Prize Offered

An annual award of $250 has been established by Henry and Ida Schuman of New York City for an original prize essay in the history of science and its cultural influences. This competition is open to graduate and undergraduate students in any American or Canadian college, university, or institute of technology. Papers submitted for the prize competition should be approximately 5000 words in length, exclusive of footnotes, and should be thoroughly documented. It is hoped that the prize-winning essay will be suitable for publication in *Isis*.

It is the wish of the donors that "the history of science and its cultural influences" be broadly interpreted. The papers may deal with the ideas and accomplishments of scientists in the past; they may trace the evolution of particular scientific concepts; or they may study the historical influences of one branch of science upon another. The phrase "cultural influences" is taken to include studies of the social and historical conditions that have influenced the growth of science, or the effects of scientific developments upon society in the realms of philosophy, religion, social thought, art and literature, economic progress, and so on. Essays dealing with medical subjects are not acceptable, although papers dealing with the relations between medicine and the natural sciences will be welcomed.

Papers submitted for competition should be sent to the Chairman of the Prize Committee, Professor Erwin Hiebert, Department of History of Science, University of Wisconsin, Madison. Inquiries about the competition may also be addressed to Professor Hiebert. To be eligible for consideration, papers must be received on or before 1 July 1960. Announcement of the prize-winning essay will be made at the annual meeting of the History of Science Society in December.

News Briefs

Genetics and embryology. The National Foundation, 800 2nd Ave., New York, has announced its first fellowship program specifically to provide training for medical students in genetics and embryology. This group of awards will help in the training of scientists needed in fields which are basic to the National Foundation's expanded research program in birth defects and arthritis.

Under the new fellowship program, which became effective on 1 January 1960, every approved medical school in the country may nominate one student who wishes to undertake a research program in genetics or embryology. The students must have completed at least a year of medical school and be able to devote a minimum of 8 weeks consecutively to full-time research. The stipend for these fellowships is $600.

* * *

Life sciences. The Division of Biological and Medical Sciences of the National Science Foundation has announced that the next closing date for receipt of basic research proposals in the life sciences is 15 January 1960. Proposals received prior to that date will be reviewed at the spring meetings of the foundation's advisory panels, and disposition will be made approximately 4 months after the closing date. Proposals received after the January closing date will be reviewed after the summer closing date of 15 May. Inquiries should be addressed to the National Science Foundation, Washington 25, D.C.

* * *

Astronomy. The International Astronomical Union will hold its 11th general assembly in August of 1961 at Berkeley. The world-wide body of astronomical scientists meets only once every 3 years. More than 1000 astronomers attended the tenth general assembly of the union a year ago in Moscow, and even more delegates are expected to participate in the Berkeley meeting.

* * *

Behavioral sciences. The American Orthopsychiatric Association will meet 25–27 February 1960 at the Sherman Hotel, Chicago. More than 4000 specialists in the behavioral sciences from all parts of the United States and Canada are expected to attend. Cochairmen of the Chicago arrangements committee are Dr. Henry L. Ruehr, Psychiatric Institute, 200 S. Michigan Ave., Chicago 4, Ill., and Miss Mildred Tate, 2336 E. 70 St., Chicago 49, Ill. For information, write to Dr. Marion F. Langer, Executive Secretary, American Orthopsychiatric Association, 1790 Broadway, New York 19, N.Y.

* * *

Human genetics. The second International Conference of Human Genetics will be held at the University of Rome, 6–12 September 1961. All meetings will be held in the conference building of the Food and Agriculture Organization of the United Nations. The organization of the conference will closely follow the successful pattern established at the first International Congress of Human Genetics, held in Copenhagen in 1956.

* * *

Reactors. Detailed information on 77 research test and experimental reactors in 22 countries is given in volume 2 of the International Atomic Energy Agency's *Directory of Reactors*, published recently. The reactors described are situated in the following countries: United States (37); United Kingdom (7); France (5); Germany (4); Canada (3); Belgium, Denmark, Italy, and Sweden (2 each); and Australia, Austria, Belgian Congo, Brazil, Greece, Iran, Israel, Korea, Norway, Portugal, Puerto Rico, Spain, and Venezuela (1 each).

The first volume of the *Directory*, dealing with power reactors in operation or under construction, was released in June 1959. A third volume, covering the remaining research reactors, will be issued in the middle of 1960. The directory, which is published in English only, is for sale through IAEA sales agents in various countries. Inquiries may also be directed to IAEA, Vienna.

* * *

Plowshare Committee. The Atomic Energy Commission has appointed a 12-member committee to advise the commission on its Plowshare Program, the investigation of peaceful uses of nuclear explosives. The committee members have been drawn from the areas of science, government, and business. Chairman of the new committee is Spofford G. English, special assistant to the general manager of the commission (acting). Plowshare is under the technical direction of the Lawrence Radiation Laboratory at Livermore, California, which is operated for the commission by the University of California.

Book Reviews

Atomic Energy in the Communist Bloc. George A. Modelski. Melbourne University Press, Melbourne, Australia; Cambridge University Press, New York, 1959. 226 pp. $5.50.

Atomic Energy in the Soviet Union. Arnold Kramish. Stanford University Press, Stanford, Calif., 1959. viii + 232 pp. $4.75.

Somewhat coincidently, these two books appear at about the same time, and they have essentially the same goal: to ascertain as accurately as possible, by careful perusal of published information, what has happened in the development and use of atomic energy behind the Iron Curtain. And the results of the two analyses are fundamentally alike, even though the dust jacket of Modelski's book states that "it contains no secrets or sensations," whereas that of Kramish's book refers to "the many startling facts contained." Actually, the first quote applies well to either book; the second is, perhaps, merely an example of all-too-frequent careless blurb-writing.

Each author faces the difficult job of constructing a believable, consistent picture of atomic energy progress from a few technical journals, the proceedings of the 1955 and 1958 Geneva Atoms-for-Peace Conferences, and such questionable sources as *Pravda* and *Izvestia*. Modelski admits frankly that "all information releases in the Soviet Union may be taken to have a propaganda purpose," but he feels that by careful reading a reasonably accurate picture can be prepared. Kramish states that "the scientific analyses are as precise as the Soviet statements on which they are based," but I am sure that he does not mean it, and instead feels that he too has found a hard core of truth.

In essence, both books represent what a research scientist would call "literature searches," which by their very nature tend to be rather dull. But they are valuable to the extent that true information can be extracted from the enormous amount of propaganda issued in the Soviet Union. The general impression created by each book is that a good job has been done in getting at the valid material; in several cases where I have firsthand knowledge of scientific developments in the Soviet Union, the relevant conclusions in both books are correct.

Although both books are similar in type and seem to have used many of the same sources of information, there are distinct differences between them. Modelski's book is a more scholarly, carefully annotated job, with an average of several footnotes per page, which refer to specific sources of information. It also contains a number of tables that cover such things as basic industrial production, the amount of electric power generated, and the number of engineering graduates. Modelski's primary subject is industrial atomic energy, which is covered in detail, not only in the Soviet Union but in the satellite countries as well. There is very little discussion of atomic bombs, and few general conclusions concerning the relative merits of communism and democracy. The many references to specific facts are valuable in building up an accurate picture, but make for rather slow reading.

The Kramish book is obviously meant for the layman, judging by the exciting chapter titles and the evident desire to make the material a bit alarming. In contrast to Modelski, the main subject of Kramish's book, and one that occupies more than half its bulk, is the story of the development of bombs in the Soviet Union and the relationship of that program to the corresponding program in the United States. Very few sources of information are quoted, and there are many interpretative statements for which no evidence is given. In particular, remarks are made, in the present journalistic fashion, implying without evidence that the Soviets are making some remarkable advance. These opinions tend to conclude chapters, such as the last sentence of chapter 10: "And for quite some time Soviet scientists have spoken of certain applications of atomic energy that are only now beginning to be appreciated in the West." Kramish clearly wins on timeliness; whereas Modelski does not cover the second Geneva Conference, in 1958, Kramish includes events as recent as Admiral Rickover's reaction to the Soviet atomic icebreaker "Lenin," which he inspected on 27 July 1959.

In summary, Kramish is probably the book for the general reader who is looking for a stimulating, easy-to-read description of atomic events in the Soviet Union, which pays particular regard to bomb development. On the other hand, the serious student who is interested in a reasonably accurate picture of the atomic industrial potentiality of the Soviet Union, together with its communist partners, would do much better to read Modelski.

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Native Peoples of South America. Julian H. Steward and Louis C. Faron. McGraw-Hill, New York, 1959. xi + 481 pp. Illus. $11.50.

This attractive book reviews, in condensed form, the content of that monumental, germinal work, *The Handbook of South American Indians*, edited between 1946 and 1950 by Steward, a coauthor of this volume. Generally, the theoretical positions taken in the earlier work are maintained here, but with some taxonomical refinements based on more recent research. Generally, too, the authors have not, as they comment (page vi), taken account of much recently available published and unpublished material, though works such as Moore's study of Inca property and law and Murra's study of Inca economy might have modified their interpretations of the Inca state and of Spanish-Inca acculturation. Similarly, recent field work on practically unknown or poorly described tribes—such as the Fulnió, Jívaro, Kraho, Kuikuru, and Yaruro—which might have modified some of the interpretations, has been omitted.

The book begins by placing native South America in the context of New and Old World cultures, and it ably discusses the proveniences of South Amer-

ican culture content from autochthonous growths out of some base-line culture brought by Asian immigrants or from transpacific or circumpolar diffusion. The authors admit that there was considerable transpacific diffusion, but affirm that it was significant only in terms of trait integrations into indigenously structured and evolving cultures. An insightful discussion of linguistic affiliations and culture history, which is based on Greenberg's recent classification, follows. The authors survey South American topography, climate, wild and domestic biota, and demography. Chiefly, the book describes, in some detail, numerous cultures or culture subtypes of the larger typology first established in the *Handbook* and refined here: central Andean, the circum-Carribean, Bolivian, Andean, and Venezuelan-Antillean chiefdoms, southern Andean "farmers," tropical forest villages, hunters, and gatherers. They also attempt some description of the European acculturation of each type. The account of central Andean acculturation strikes me as most stimulating and suggestive for further research.

Despite the over-all excellence, I am bothered by theoretical inconsistencies which mar the book. In different contexts, disparate explanations for similar phenomena are given. Warfare is alternately said to be waged for prestige, loot, religious motives, trophies, land, or resources. Though it is obvious that forms of warfare varied, the data presented indicate clearly that ecological causes of warfare were *always* present, whatever other motives became functionally fused with ecological stimuli. By giving a consistent account of warfare, the authors might have elicited cultural regularities such as have interested them in previous works, associated with the evolution of cultural ecologies. Such regularities are implicit in their stage treatment of Andean culture history. Again, from students of cultural evolution, I am amazed by this remarkable statement (page 65): "Central Andean cultural development had probably fulfilled its native potentialities by the time of the Spanish Conquest. It is very doubtful that it could have acquired any radically new patterns through internal evolution alone." The absence of iron ores (recently found in plenty in Peru) is given as one reason for this (page 141). Further, why should the Inca's "exalted status" (pages 125 and 134) entail brother-sister marriage? Since monarchs equally exalted in other cultures did not marry sororially, factors other than exaltation must have operated to cause sibling marriage. The analysis of social types and surplus production (pages 60–64) seems equally faulty in its application of current principles. The book would have been a much stronger document if these principles of our science, to the development of which both authors have contributed, had been consistently used as the framework of their cultural analysis.

I am also bothered by unnecessary errors. The Mundurucú are said to have matrilineages (page 338), though Murphy specifically denies this [*Am. Anthropologist* **58**, 425 (1956)]. The Spanish are said to have been patrilineal (page 154); Murdock classifies them as bilateral [*Am. Anthropologist* **59**, 678 (1957)]. The authors mention a creator moon-goddess for the Yaruro; this is not to be found in *Petrullo* or in the *Handbook*. Most of the Yaruro ecological, social organizational, and settlement data are erroneous, as later field work by Le Besnerais (1954) and me has shown. The "Guahibo and Chiricoa"—the latter is the Yaruro name for the former—are still classified as hunters and gatherers, though Wilbert mentions that they sometimes had gardens [*Southwest J. Anthropol.* **13**, 88 (1957)], and I observed them burning swiddens. The evidence presently suggests that horticulture was aboriginal among both groups. One may question whether Benvenuto Cellini (1500–71) worked for "feudal lords," and whether by the 16th century the Industrial Revolution, in any ordinary usage of the term, had occurred anywhere in Europe, let alone in Spain as the authors suggest (pages 146–47).

Despite these criticisms, the book is most welcome, and it shows the great progress made since Radin's *Indians of South America*, only 13 years ago. It again demonstrates the fundamental importance of a vast taxonomic ordering of data, such as Steward's ever-basic *Handbook*. Though the price is exorbitant, the book is a useful compendium and introduction, tastefully illustrated with unusually select photographs and drawings, to the study of South America, for professionals and students alike.

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The Fifth Mental Measurements Yearbook. Oscar Krisen Buros, Ed. Gryphon Press, Highland Park, N.J., 1959. xxx + 1292 pp. $22.50.

In 1292 staggering pages, Oscar K. Buros has perpetuated his service to test constructors, test publishers, and (most importantly) test users. Under his impeccable editorship, this fifth edition of the *Yearbook* lists 957 tests and presents 698 original test reviews by 350 well-qualified reviewers and 48 excerpts from test reviews published in 16 journals. It provides 6468 references on specific tests, lists 485 books on measurements, and quotes 535 excerpts from book reviews. Although the latter are useful, they do not constitute the unique contribution provided by the original reviews of tests, which in general are evaluative, informative, and thought-provoking. The volume covers the period from 1952 to 1958. Supplementing earlier volumes, it attempts to cover all commercially available tests and all measurement books published in English-speaking countries.

Buros' objectives are: "To make available . . . test reviews which will assist test users to make more discriminating selections of . . . tests; . . . to impel authors and publishers to place fewer but better tests on the market . . .; and to impress test users with the desirability of suspecting all standard tests—even those prepared by well-known authorities—unaccompanied by data on their construction, validation, use, and limitations."

Despite this truly remarkable series, large numbers of what ought to be unsalable tests continue to flood the market, if Buros' reviewers are correct. Test specialists are painfully aware, also, that significant use is being made of many tests unaccompanied by interpretable data to substantiate their value.

I can but concur with reviewers of earlier volumes that this effort is "monumental," "indispensable," and "encyclopedic," and that it is a "bibliographer's dream," a "milestone," and a "must." It should be available, however, not only to students and teachers of testing and users of educational tests, but also in any industrial organization and public service agency that contemplates the purchase and use of any kind of test for personnel selection. At $22.50, this book is cheap.

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Comparative Anatomy. William Montagna. Wiley, New York; Chapman and Hall, London, 1959. xii + 397 pp. Illus. $6.

"This book is written for the college sophomore for a one-semester course" is the first sentence in this book's preface. After reading the book, I feel that the author has very successfully fulfilled his aims. This is not the first stimulating text on comparative anatomy to come out of Brown University, but it is very different from the previous one (by Walter). Walter's book, a series of lectures delivered by a very good lecturer, was used by many teachers, not as a textbook but as a source for preparing clever lectures while another, less lively text was used in class. Montagna's work is a textbook in every sense. Every word counts, and every sentence contributes to the development of the subject. One might refer to this book for facts, but not for material to adorn a lecture. The facts presented are well chosen, and they are within the limits of sophomores' abilities.

The first few pages are deceptively easy. The definitions are so simple that they seem almost trivial. On two occasions I have seen smart 14-year-old youngsters pick up the book, read it for half an hour, and then put it down because the difficulty of the material increases very rapidly, and soon demands very close study. By the time a student finishes the chapter on the endoskeleton, he will realize that he is no longer a freshman, and that he has tackled something of considerable depth and complexity. The treatment is clear throughout, but demands concentration. The easy start is a wise procedure.

There are a few points that I do not like. The first is the practice of applying men's names to structures rather than the descriptive terms of more recent anatomical practice. Since these names were applied first in human anatomy, their use in a book on comparative anatomy seems unwise. Because most texts on human anatomy now use the more modern nomenclature, this is an unnecessary duplication of terms which detracts from the comparative aspects of anatomy. There is too little paleontology and possibly too much embryology, but these are matters of individual taste. A very few statements of fact may need correction. These are minor points, and the text is so sound that the lecturer can take class time to elaborate on any aspect of the subject which he considers inadequately treated.

Against these trivial detractions must be set the text's many excellent departures. The freedom from copying previous work is refreshing. This freedom shows in both the text and the illustrations. The introduction to the chapter on the muscular system is possibly the best in the book, or in any comparative anatomy text written for undergraduates. The book is well printed on good paper. It should stand up under hard use. It is not a reviewer's duty to discuss anything except the book under review, but since many of this review's readers may consider using the book as a text, I take the liberty of pointing out that a laboratory manual is available to accompany the text, and that the manual should be revised. Not only does it mix up terms such as "lateral and medial" and "dorsal and ventral," but the nomenclature differs from the nomenclature of the text. There are some conspicuous errors of fact, yet it is a good manual with a broad coverage, which omits only work on the skin and its appendages. With these reservations, I am convinced that a stimulating and informative course could be built on these two books.

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Grasslands. A symposium. Howard B. Sprague, Ed. Publ. No. 53. American Association for the Advancement of Science, Washington, D.C., 1959. xv + 406 pp. Illus. Prepaid to members, $8; others, $9.

The conservation movement, in any effective sense, is now a half century old. As launched by Roosevelt I, its most dramatic aspect was centered about our forests. It its a pleasure to record, on the basis of recent visits to the Northwest and others to the southern pine region, that American forestry is coming of age.

Unfortunately, while cowpokes may be more romantic than lumberjacks, the grasslands where they work seem to have less appeal than the woods. It was, I believe, during Theodore Roosevelt's reign that a scientist in the Department of Agriculture addressed a memorandum to the secretary, calling attention to the serious deterioration of the western range, due to overgrazing and general mismanagement. The document was returned, endorsed "Probably true, but best not to do anything about it now." Actually our grasslands have suffered fully as much damage as our forests. Fortunately their cycle of recuperation is somewhat briefer, unless erosion has been severe.

Students of the food pyramid estimate that a unit of animal produce requires seven to ten units of plant material, and a similar ratio holds between meat eaters and meat. To the extent that we depend upon animal proteins and fats, each pound of us, therefore, represents from 343 to 1000 pounds of grain or forage—the former from cultivated lands, the latter from grasslands proper.

The area of grasslands in this country is about one billion acres—roughly three times that in all harvested crops except hay and, of course, timber. Much of this grassland never was, and probably never will be, highly productive. It follows, then, that grasslands are pretty basic to our economy and that their condition is a matter of grave importance.

In publishing this volume, *Grasslands*, and in sponsoring the symposium on which it is based, the American Association for the Advancement of Science has performed a public service. And so has Howard B. Sprague, who has ridden herd on some 44 authors of 37 papers; he deserves praise for doing well the kind of an editing job that is difficult at best. Except for an occasional rather perfunctory paper, the amount and the quality of information is highly satisfactory. It is also well presented.

It is impossible to summarize so complex a discussion. In it a rich array of the sciences has been marshalled—biochemistry, genetics, entomology, engineering, climatology, soils, pathology, and, of course, ecology. There is a record of much work well done and a clear indication that much more is needed. The general import is one of a much higher potential than is now enjoyed.

Some 15 million acres in the Northeastern States and some 60 million acres in the Corn Belt are reckoned as grassland. Despite the rapid growth of the livestock industry in the South it is these two areas and the drier grasslands of the West that receive chief attention. Broadly speaking, the technology of the more humid regions is one of intensive,

largely artificial operations. In the subhumid and semiarid grasslands, management is more largely a matter of understanding and taking advantage of ecological factors—seeing that nature gets a chance to do the work. While it is true that each landscape is in some respects unique, we already have, thanks to Weaver and his industrious associates, a lot of information on the western grasslands that we should be using. Meanwhile eastern workers, both state and federal, have done much to improve our knowledge of intensive management under humid conditions.

Our present food surpluses should not blind us to the fact that we are living in a hungry world. Our own rate of population increase suggests that, even if we consider only ourselves, we shall soon be seriously concerned with adequate food production. On both counts the present volume deserves attention.

PAUL B. SEARS
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Maya. The riddle and rediscovery of a lost civilization. Charles Gallenkamp. McKay, New York, 1959. xvi + 240 pp. Illus. + plates. $5.50.

Whatever the causes may be, it has been evident that for some time now there is an increasing market for books, written in "layman" style, on archeology. A fair proportion of these books have been devoted to American archeology, particularly to the high culture areas of Middle America and the central Andes. Gallenkamp's book concentrates on the pre-Columbian Maya, a group that occupied the scrub and rain forests of the Yucatan Peninsula of Central America. Thanks to modern transportation and the interest of the various governments in the tourist potential and the scientific value of the many Maya sites within this area, an increasing number of people are able to visit the impressive, often awesome ruins that until recently could be reached only by the most determined of travelers and scholars. One might wonder, however, how many visitors leave a site such as Uxmal, or Tikal, or Copan with any substantial awareness of the historical and anthropological implications of what they have seen. Are monuments, temples, and palaces akin to some museum objects—poorly labeled and without sensible context—at most just attractive "things"? The chances are though that the majority of visitors come away with many valid questions. Does a book such as this one by Gallenkamp properly answer what is answerable and provide a context for a searching appreciation of all the carvings and structures no longer so "lost" in the jungle?

The book is thoroughly readable and reasonably well illustrated with a selection of photographs covering various outstanding Maya remains. The major periods of Maya development are covered, from the still slightly known Formative era through the relatively well investigated Classic or florescent period, to the final period of militarism, secularism and, in many ways esthetic disintegration. A chapter is devoted to John Lloyd Stephens, whose explorations over a century ago marked the beginning of our archeological knowledge of the Maya. A chapter on how the Americas were populated with subsequent cultural diversification, is well done. Other chapters are given to the famed Classic-period tomb found a few years ago at Palenque and to the equally well publicized polychromed frescos of Bonampak. The rich yield from the "Sacred Cenote" (well) of Chichen Itza in Yucatan is similarly treated as a highlight of discovery and an interpretive source.

On the whole, Gallenkamp's book appears to be free of all but minor error (for example, Tikal "Temple V" in one photograph is actually "Temple VI"), and to be generally comprehensive and very much up to date. A good bibliography is appended. In fact, the book often appears to be a synthesis of two prior popular studies—J. E. S. Thompson's *The Rise and Fall of Maya Civilization* (University of Oklahoma Press), and S. G. Morley's *The Ancient Maya* (G. Brainerd, Ed., Stanford University Press). Full credit is given to these sources, and it is evident that Gallenkamp has heavily relied upon them. The question is, if one must choose one of these three books, whether that by Gallenkamp would be the choice. I would certainly favor the revised edition of Morley's study for detail and that by Thompson for an often penetrating view of Maya culture. Another excellent study is George Brainerd's *The Maya Civilization* (Southwest Museum, Los Angeles).

In summary, the Gallenkamp volume should certainly be recommended as an adequate, up-to-date, and reliable presentation of a fascinating subject of interest to anyone concerned with the comparative study of what causes and constitutes "civilization." However, his principal sources, written by men long and actively concerned with the subject, cannot be recommended enough.

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The Physico-chemical Constants of Binary Systems in Concentrated Solutions. vol. 1, Two Organic Compounds (without hydroxyl derivatives). 1274 pp. vol. 2, Two Organic Compounds (at least one a hydroxyl derivative). 1283 pp. Jean Timmermans. Interscience, New York, 1959. $29 each.

These are the first two volumes of a four-volume work aimed at extracting from the literature all of the data on the physical constants of solutions of two components. Elements and compounds are taken as components; alloys and solutions more dilute than 10-weight percent are excluded from consideration.

The first two volumes consist of tables of data on binary systems of the type indicated in the title. Apparently all of the published data on a given system are included without critical evaluation; thus, the user will find reference to the original reports necessary for obtaining an idea of the accuracy of the determinations. Since the bibliography is to appear in the fourth (and last) volume of the series, which is not yet available, the single volumes appear to be of limited usefulness at the present time. Although the arrangement of compounds is quite systematic, the index to compounds is also to appear in the last volume; therefore locating a particular compound in the very large mass of data reported in the first two volumes is a chore.

The work is reproduced from typewritten records by offset printing, and although the print is easy to read, the tables, in many instances, are rather carelessly aligned on the page. Further, a cursory inspection reveals several typographical errors in names of compounds; this would hardly encourage one to regard the numerical data as completely reliable without checking the original source. While the complete set of four volumes will undoubtedly be

useful for reference, and as a guide to the published data, any need for a critically evaluated tabulation of such data does not seem to be filled here.

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The Orchids. A scientific survey. Carl L. Withner, Ed. Ronald Press, New York, 1959. ix + 648 pp. Illus. $14.

The Orchidaceae, one of the largest plant families, has until recently been neglected by students of the various phases of botany, except taxonomy. Withner's book, long awaited by scientists, horticulturists, and amateurs, attempts to bridge this gap for the first time.

The various phases of orchid biology are discussed by 16 scientists and horticulturists. "Not only have the several authors covered their respective fields as they exist at present, but they have attempted to correlate and evaluate the researches of different scientists so that the body of information included in this book means much more than an annotated bibliography or a report on a number of scattered papers." In fact, ideas for further research may be based upon the following informative chapters: "Classification," "Developmental anatomy," "Aspects of variation," "Embryology," "Orchids and cytology," "Hybridization," "Physiology," "Mycorrhiza of orchids," "Photoperiodic and temperature responses," "Fungal and bacterial diseases," "Virus diseases," "Orchid pests and their control," and "Vanilla, the orchid of commerce."

Perhaps one of the most valuable contributions of the book is its key to the tribes and subtribes of the family, presented for the first time in English, and thus making understandable and available to the public the intricate correlation among the various groupings in a field previously limited to scientists. Special mention also should be made of the two-fold approach in the chapter "Orchids and cytology." "This chapter has been written for two types of readers: one who knows little about orchids but a great deal about cytology, and the other who knows a great deal about orchids but little about cytology. An attempt has been made here to satisfy both without offending either, by assembling the information in the framework of the history of cytology in orchids and by incorporating the results of research of the author not published elsewhere."

Of course, as with most scientific books, *The Orchids* has its shortcomings. One would expect that a scientific survey of a family would contribute towards the understanding of such problems as origin, evolution, distribution, and biogeography. Unfortunately these important and basic phases are not included in this scientific survey.

In general, I welcome *The Orchids* as the first and as a comprehensive scientific treatise on the family as a biological unit, and I hope that other readers will find it to be a useful source of information.

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New Books

Advances in Agronomy. vol. 11. A. G. Norman, Ed. Academic Press, New York, 1959. 438 pp. $12. Contents: "Water and its relation to soils and crops," "The economics of fertilizer use in crop production," "Recent developments in agricultural machinery," "Fertilizer production and technology," "Soils and land use in the Netherlands," "Effect of nitrogen on the availability of soil and fertilizer phosphorus to plants."

A History of the American Dental Association. A century of health service. Robert W. McCluggage. American Dental Assoc., Chicago, Ill., 1959. 520 pp. In the introduction Richard H. Shryock says, "This isolation of one specialty [dentistry] as a distinct guild is one of the most interesting phenomena in the history of medicine as a whole. In order to understand it, one needs to follow the evolution of dental practice, and particularly the development of what may be termed "organized dentistry" in the United States. It is just this theme which is followed in the present work."

Scientific Manpower, 1958. Papers of the seventh conference on scientific manpower. Symposium on demographic and sociological aspects of scientific manpower. National Science Foundation, Washington, D.C., 1959. This report is the third in a series of annual summaries of developments relating to scientific manpower. The report contains the papers of the annual scientific manpower conference held during the meeting of the AAAS; it also contains four papers on related topics read at a meeting sponsored by the American Sociological Society.

Solid State Physics. Advances in research and applications. vol. 9. Frederick Seitz and David Turnbull, Eds. Academic Press, New York, 1959. 563 pp. $14.50. Contents: "The electronic spectra of aromatic molecular crystals" (H. C. Wolf); "Polar semiconductors" (W. W. Scanlon); "Static electrification of solids" (D. J. Montgomery); "The interdependence of solid state physics and angular distribution of nuclear radiations" (E. Heer and T. B. Novey); "Oscillatory behavior of magnetic susceptibility and electronic conductivity" (A. H. Kahn and H. P. R. Frederikse); "Heterogeneities in solid solutions" (A. Guinier); and "Electronic spectra of molecules and ions in crystals." Part 2, "Spectra of ions in crystals" (Donald S. McClure).

Soil, Grass and Cancer. Health of animals and men is linked to the mineral balance of the soil. André Voisin. Translated from the French by Catherine T. M. Herriot and Henry Kennedy. Philosophical Library, New York, 1959. 319 pp. $15.

Reprints

Civilization. V. F. Lenzen, Stephen C. Pepper, George P. Adams, D. S. Mackay, Edward W. Strong, A. I. Melden, William R. Dennes. Univ. of California Press, Berkeley, 1959 (originally published as vol. 23 of the University of California's *Publications in Philosophy*, 1941). 184 pp. $1.50. In the preface Dennes writes that "In these studies, first published seventeen years ago, the authors examined issues which in 1941 they judged to be fundamental in the twin enterprises of explaining and evaluating patterns of human social living. Their republication invites us to consider whether the processes of history during two turbulent decades, or the progress of philosophical interpretation and criticism, have either resolved or moved beyond the problems here discussed, or whether and in what respects the analyses are still relevant."

Folkways. A study of the sociological importance of usages, manners, customs, mores, and morals. William Graham Sumner. Dover, New York, 1959 (unabridged republication of 1906 ed). 699 pp. $2.49. Sumner, who was a professor of political and social science at Yale University from 1872 until his death in 1910, provided an examination of usages, manners, customs, mores and morals. Among the subjects treated in this work are characteristics of the mores, societal selection, infanticide, killing the old, the social codes, primitive justice, and popular sports.

An Elementary Treatise on Fourier's Series and Spherical, Cylindrical, and Ellipsoidal Harmonics. With applications to problems in mathematical physics. William Elwood Byerly. Dover, New York, 1959 (unabridged republication of the last edition; originally published by Ginn, 1893). 296 pp. $1.75.

A History of Science, Technology and Philosophy. In the 16th and 17th centuries. vol. 1 and vol. 2. A. Wolf. Second edition prepared by Douglas McKie. Harper, New York, 1959 (reprinted from ed. 2, 1950). 686 pp. $1.95 each. The earlier edition was described by I. Bernard Cohen in *Isis* as "An indispensable work for studying the period. . . ."

On Understanding Physics., W. H. Watson. Harper, New York, 1959 (reprint of 1938 edition). 160 pp. $1.25.

Reports

On Pleistocene Surface Temperatures of the North Atlantic and Arctic Oceans

Abstract. Two additional interpretations are given for the important data of D. B. Ericson on the correlation of coiling directions of *Globigerina pachyderma* in late Pleistocene North Atlantic sediments with ocean surface temperatures. One interpretation relates the distribution of this species to the distribution and circulation of ocean water masses. On the basis of our ice-age theory, our second interpretation uses the data and correlations of Ericson to establish temperature limits of a thermal node, a line on which glacial and interglacial temperatures were equal, for the North Atlantic Ocean. This line crosses the strait between Greenland and Scandinavia. Further, Ericson's interpretation of the 7.2°C isotherm implies that the glacial-stage surface waters of the Arctic Ocean were between 0° and 3.5°C.

In a recent paper, Ericson (*1*) has supplied paleontological evidence from which he draws certain quantitative conclusions about surface temperatures in the North Atlantic and Arctic oceans during late Pleistocene time. He shows that the present 7.2°C April isotherm (taken from the 45°F isotherm), which follows the northern boundary of the Gulf Stream to Iceland and then swings eastward to the Faroe Islands, separates the occurrence of sinistral and dextral *Globigerina pachyderma* found in the upper sediments of cores. The former lie to the north and the latter to the south of this boundary. Previous positions of this boundary have been traced by the study of coiling ratios from lower samples of the cores. Ericson reports that "during late Pleistocene time the boundary between the provinces of right and left coiling was never much farther north than it is now, but at other times it was a good deal farther south."

Ericson states that his conclusions (that is, that the temperature was lower in late Pleistocene time than at present in a zone "extending a good deal farther south" of the 7.2°C April isotherm, and not as warm as 7.2°C in the Arctic Basin and the Norwegian and Greenland seas) appear to be strongly supported by both the horizontal and vertical distributions of all observed species of *Globorotalia,* which have proved to be very reliable temperature indicators (*2*).

With our present state of knowledge regarding the living habits of foraminifera and the circulation of water masses and hydrography of the ocean, two additional interpretations of Ericson's data and conclusions seem possible.

1) It should be noted that Ericson's faunal boundary and the 7.2°C isotherm both follow the northern margin of the Gulf Stream and North Atlantic Drift where strong convergence and very steep temperature gradients exist. Certainly the isotherms here are so closely spaced as to be indistinguishable on the basis of sedimentary faunal content. This is probably also true between Iceland and the Shetland Islands, where the isotherm divergence shown on existing Hydrographic Office charts is no longer to be regarded as accurate. Ericson's selection of only the April isotherm positions seems open to question, despite the apparently fortuitous fit. It may well be that each variant of *Globigerina pachyderma* is associated with a particular water mass rather than with a critical range of surface temperatures.

This implies that Ericson's data show the way to map former positions of a major ocean current. Core material is available for testing this possibility on the antarctic convergence in the Scotia Sea, and perhaps a similar procedure can be used in the charting of paleopositions of many of the major ocean currents.

2) However, if Ericson's correlations are correct, then important quantitative deductions pertinent to our theory of ice ages (*3*) can be drawn from his work. It is fundamental to this theory that during a glacial stage there is an increased interchange of water between the Arctic and the North Atlantic which warms the former and cools the latter. In fact, the abruptness of the temperature rise in the Atlantic at the end of Wisconsin time, as recorded in sediments, was the starting point for this theory.

It is an obvious consequence of our theory that there must be a thermal node separating the Arctic region, which became warmer, from the North Atlantic region, which became cooler during the glacial stage. It seemed highly probable to us that this temperature node would be in the strait connecting the two major basins. If Ericson's interpretation is assumed to be correct, then the present 7.2°C April isotherm clearly establishes the southern limit of this node. The northern limit must of course lie to the south of the pack ice. It seems quite significant that this nodal region approximates the strait that we regarded to be so critical in the interchange of Atlantic with Arctic waters.

Until some organism or other method is found that will permit a narrowing of the nodal limits based on Ericson's data, it is suggested that the node be located at the central position corresponding to the 3.5°C isotherm, roughly between the pack ice and Ericson's faunal boundary, as shown in his Fig. 1. On the basis of this, it can be concluded from our theory that the Arctic surface waters during a glacial stage were between 0° and 3.5°C.

Although it is quite difficult to prove the association of the variants of *Globigerina pachyderma* with particular water masses at present, owing to the complicated structure of the Gulf Stream and the North Atlantic Drift, it seems that our second interpretation, while quite consistent with our ice-age theory, is nevertheless founded on some questionable correlations. We therefore cannot consider the problem as settled, but there seems to be no justification for Ericson's conclusion that Pleistocene refrigeration was the result of a reduction on total radiation from the sun and not a consequence of some purely terrestrial cause (*4*).

MAURICE EWING
WILLIAM L. DONN
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4. This paper is contribution No. 392 of the Lamont Geological Observatory.

31 August 1959

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Genetic and Environmental Control of Flowering in Trifolium repens in the Tropics

Abstract. *Trifolium repens* at low elevations expressed wide genetic variation in tendency to flower. Clones classified as flowering or nonflowering were subjected to temperatures associated with high elevations. Flowering in "nonflowering" clones was induced under warm-day- cool-night treatments. It is proposed that in the tropics, low temperatures associated with high elevations are an important factor in determining flowering, and therefore ability to persist, in plants which are long-day and temperature sensitive.

The role of climate in controlling vegetative and reproductive phases of plant development is a major factor in plant distribution (*1*) as well as of immediate concern to plant producers. Many plants are grown in a climate quite different from that where the seed was produced. *Trifolium repens* has long been grown in Hawaii, where it flourishes in higher elevations. As it has been considered a long-day plant, its flowering ability poses a problem, since tropical days do not attain the length of those in the temperate zone. Low night temperatures are known to promote flowering in a number of long-day plants (*2*). Roberts and Struckmeyer (*3*) tested *T. repens* as one of some 120 species and varieties of plants. Under Wisconsin greenhouse conditions, flowering in the species was demonstrated by cold-night treatment. Quantitative studies were desirable on this point, particularly as they relate to field conditions. The role of genetic factors also needed clarification.

Field collections in Hawaii of *T. repens* showed wide genetic diversity in flowering tendency. Clones at Honolulu (elevation 70 feet) manifested all degrees of flowering from none to profuse. Field experiments with plants grown at different elevations had suggested that temperature under Hawaiian conditions did have a profound effect on flowering. Experiments were therefore planned to shed light on this problem by the use of a controlled environment cabinet. The cabinet was designed to produce diurnal fluctuations of temperature as well as any desired length of day. The "day" temperature was set at 65°±3°F, and the "night" at 47°±3°F, the temperatures found at a high elevation station in the field experiments. A 13-hour day length was chosen because this approached the maximum long day found at Honolulu.

Two clones, A and B, which flowered under Honolulu conditions, and three which did not, C, D, and E, were chosen. Sufficient cuttings of each clone, for four treatments each with six replicates, were grown in vermiculite. They were watered three times a week with Hoagland's solution and the other days with tap water.

The four treatments were as follows. The first group was grown outdoors under Honolulu conditions subject to the summer temperature of Honolulu (13 June—30 Sept.). Because of Honolulu's maritime climate, variation was not great. The mean maximum temperature was 83.1° and the range was 77° to 88°F. The mean minimum was 72.3° and the range was 63° to 77°F. This treatment group was subject to warm days and warm nights. The second treatment group remained in the cabinet and thus was subject to cool days and nights. A third group was moved to outdoors for 8 hours during the day and then into the cabinet at night so that it was subject to warm days and cool nights. The fourth group was placed in the cabinet for 8 hours each day and then moved outdoors. It was thus subject to cool days and warm nights.

Results are shown in Fig. 1. The data show that the "nonflowering" clones, C, D, and E, produced flowers when subjected to the warm-day and cool-night treatment (third group). No other treatment was successful in inducing flowering in C, D, and E. Flowering in the clones A and B was reduced by a cool-day, warm-night treatment. (Vegetative growth was also reduced in this particular treatment.)

The experiment was repeated, omitting treatment 4 (cold-day, warm-night) and clone D. The same results were obtained, that is, the warm day, cool-night treatment produced flowers in the "nonflowering" clones.

The work shows that flowering in the "nonflowering" clones is promoted by subjecting them to cold night temperatures, even though they were exposed to the warm days of Honolulu. It is therefore apparent that the low night temperature associated with the high elevation station is the probable mechanism for triggering flowering in these clones. This work is in agreement with that found by Hiesey for *Poa* (*4*).

It should also be emphasized that certain clones (A, B) flowered freely without being subject to cold nights, indicating that flowering in this species may be considered a phenotypic response of the genotype to its environment, just as are morphological characters. As with some morphological characters, there is apparent wide genetic diversity within the species.

The failure to flower of clones C, D, and E in the cabinet (cold-day, cold-night) was unexpected. Two possibilities exist. The first is that the light intensity in the cabinet was not sufficient to produce good flowering. The second is that low night temperatures are not the stimulating agent for flowering, but rather the change in temperature.

The results are of practical value because the seed of many forage crops is produced in areas where environmental conditions are quite different from the area where the crop itself is to be produced. If a crop consists of a mixture of phenotypes, the environmental conditions of the area in which the seed is produced may tend to favor some phenotypes over others by virtue of differential flowering. Therefore, an un-

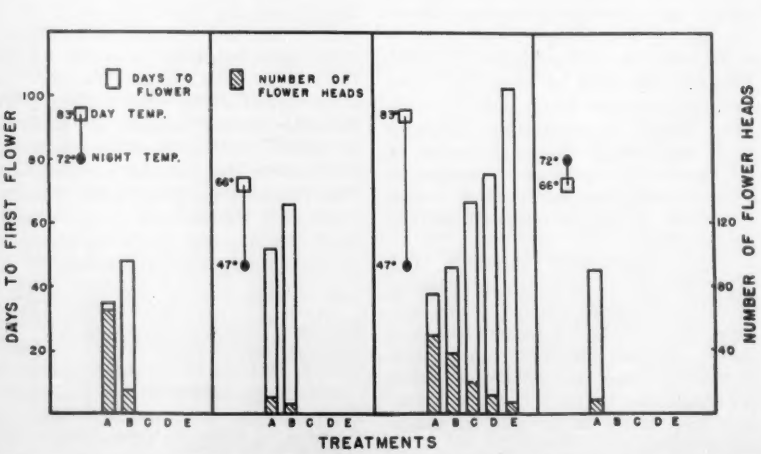

Fig. 1. Response of five clones, A, B, C, D, and E, of *Trifolium repens* to different temperature treatments. The "nonflowering" clones, C, D, and E, flowered only under warm-day and cool-night treatment. Clear bars represent days to first flower (mean of six replicates). Shaded bars represent number of flower heads (total of six replicates).

conscious selection may be carried on.

The findings present an interesting picture of reproduction of long-day, temperature zone plants introduced to the tropics. It is shown that low night temperatures, or changes of temperature associated with high elevations, constitute a mechanism for inducing flowering. The ability of such plants to persist is, therefore, apparent (*5*).

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5. This study was supported, in part, by Western Regional Technical Committee W-58. Published with the approval of the director, Hawaii Agricultural Experiment Station, as miscellaneous paper No. 113.

21 August 1959

Mammalian Liver β-Glucuronidase for Hydrolysis of Steroidal Conjugates

Abstract. Although the rate of hydrolysis by mammalian β-glucuronidase appears to be inhibited by methylene chloride or carbon tetrachloride with the standard technique (phenolphthalein glucuronide as a substrate), the release of steroidal conjugates under conditions generally employed does not appear to be affected.

Gautney *et al.* (*1*) have recently described the potentiating effect of several organic solvents (aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, aliphatic alcohols) on bacterial β-glucuronidase, thus extending an earlier report concerning chloroform (*2*). The authors, however, found that dichloromethane and chloroform inhibit the hydrolysis of phenolphthalein glucuronide by mammalian liver enzyme. This raises the question whether mammalian liver β-glucuronidase is suitable for hydrolysis of steroidal glucuronides in biological fluids which have previously been extracted with such solvents.

Table 1. Effect of solvents on hydrolysis by liver β-glucuronidase of various glucuronides.

Enzyme units/ml	Control (No solvent)	Dichloromethane (% Aglycon)	Carbon Tetrachloride (% Aglycon)
	Phenolphthalein		
6.25	2.2	1.0	2.8
12.5	5.4	2.2	4.9
25.0	15.0	4.7	12.7
50.0	32.0	9.7	30.0
250.0	69.0	54.0	71.5
1000.0	100.0	98.0	100.0
	17-Ketosteroids		
10.0	16.0	9.4	10.7
100.0	45.2	43.3	41.0
500.0	100.0	96.0	94.0
	Corticoids		
10.0	16.0	14.0	13.3
100.0	58.5	67.5	62.3
250.0	85.5	81.3	81.0
500.0	100.0	99.5	100.0

Previous studies in our laboratory had demonstrated quantitative release of the free steroid when pregnane-3α, 17α, 21-triol-11, 20-dione monoglucuronide, added to human plasma previously extracted with dichloromethane, was incubated with 300 to 500 Fishman units of mammalian β-glucuronidase per milliliter (*3*). In view of the implications of Gautney's (*1*) results, this matter was reinvestigated.

A pool of human urine was divided into aliquots of 10 ml, and duplicates were equilibrated with either dichloromethane or carbon tetrachloride. Thereafter the urine was incubated with beef liver β-glucuronidase (*4*) in doses of 10 to 500 Fishman units per milliliter at *p*H 4.5, 37°C for 48 hours. The 17-ketosteroids were extracted and measured as reported elsewhere (*5*), and the urinary corticoids were determined by the method of Silber and Porter (*6*). In addition, the mammalian enzyme was studied by use of phenolphthalein glucuronide as substrate after the manner of Talalay *et al.* (*7*), with the addition of 0.1 ml of the organic solvent to replicate digestion mixtures employed by Gautney (*1*) in his investigation.

The results (Table 1) are expressed as percentage of maximal hydrolysis achieved with each substrate. In agreement with Gautney *et al.* (*1*), the solvents inhibited hydrolysis of phenolphthalein glucuronide by the low concentrations of enzyme often employed. On the other hand, under the conditions of incubation with high enzyme concentrations for 48 hours, as generally described for hydrolysis of steroid conjugates (*3, 8*), no significant inhibition was apparent. At lower concentration of enzyme the solvents only slightly reduced the partial hydrolysis of steroid glucuronides. These results do not support the assertion by Gautney *et al.* (*1*) that such solvents must not be used for prior extraction if liver β-glucuronidase is to be employed for subsequent hydrolysis of steroid glucuronides.

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1 July 1959

Glucuronidase Activation: Enzyme Action at an Interface

Abstract. The potentiating action of chloroform on bacterial β-glucuronidase has been shown to increase as the interface area between the two liquid phases increases. Prior extraction of the enzyme with chloroform causes a loss rather than an increase in activity. It is tentatively suggested that the correlation between activity and interface area may reflect a phenomenon of enzyme action at a liquid/liquid interface.

In an investigation of the "paradoxical" effect of organic solvents on the activity of animal and bacterial β-glucuronidase, which was first observed with chloroform (*1*), and more recently with other solvents by Gautney, Barker, and Hill (*2*), we have also observed an activation of the bacterial enzyme (*3*) varying in degree with the solvent used and a similar inactivation of the animal enzyme (*4*). We have further noted that the activation of the bacterial enzyme seems not to be due to the removal of an inhibitor, since prior extraction of the enzyme solution by shaking with one volume of chloroform for 5 minutes causes a 40 percent loss rather than an increase in activity. An activation such as that noted by Bernfeld, Jacobsen, and Bernfeld (*5*) has been ruled out by the work of Gautney, Barker, and Hill. Moreover, the continuous removal of phenolphthalein from the reaction site cannot account for the inverse effect on the animal and bacterial enzymes. These facts suggest that some physicochemical property of these enzymes is involved in the activation by solvents. The preliminary results reported here relate to this problem.

The assay method used in this study is that suggested by the Sigma Chemical

Table 1. Effect of varying the interface area on the activation of bacterial β-glucuronidase by a constant volume of chloroform. Assay mixture, 0.5 ml of 0.2-percent glucuronidase; 0.5 ml of 0.075*M* phosphate buffer, *p*H 6.8; and 0.5 ml of 0.015*M* substrate. Volume of chloroform, 1 ml.

Interface area (approx.) (cm^2)	Activity (per gm)
0	25,500
0.38	61,500
0.95	78,000
2.0	88,000

Table 2. Activation of bacterial β-glucuronidase by 0.1 ml of chloroform present as a layer and as an emulsion. Assay mixture as in Table 1; incubation in 15 × 125-mm test tubes.

Condition of chloroform	Activity (per gm)
None	25,500
Layer	71,000
Emulsion (a)*	81,000
Emulsion (b)*	95,000

* The chloroform was more finely divided in (b) than in (a).

Co. (*6*) and is based on that of Talalay, Fishman, and Huggins (*7*). Phenolphthalein glucuronide is used as substrate, but incubation is in 0.075*M* phosphate buffer at *p*H 6.8. Action of the enzyme is stopped by the addition of 0.2*M* glycine buffer at *p*H 10.4. In our experiments the tubes containing the assay mixture and the solvent were restoppered after the addition of the glycine buffer and then shaken vigorously and centrifuged in order to ensure equilibration of phenolphthalein between the solvent and the alkaline aqueous phase.

When a constant volume of chloroform is incubated with the assay mixture in vessels of different dimensions, so as to vary the interface area between the two liquids, there is an increasing activation of the enzyme as the interface area increases (Table 1). This same increase in activation with a constant volume of chloroform can be achieved by merely shaking the vessel prior to incubation so as to emulsify the chloroform and thus increase the interface area (Table 2). When the vessel is thus shaken, the extent of activation is dependent on the degree of visible emulsification. Conversely, if the interface area is maintained constant while the volume of chloroform is varied, the degree of activation of the enzyme remains constant and independent of the volume of chloroform. Thus, when the assay mixture is layered over volumes of chloroform varying from 5 to 13 ml, with an interface area of 0.38 cm^2, the activity averaged 45,000 (range 42,000 to 47,000)—that is, less than 50 percent of that produced by 0.1 ml of chloroform present as an emulsion. The fact that this value is somewhat less than that for the same interface area in Table 1 is due to the day-to-day variation often observed in the assay of glucuronidase activity (*1*). However, its constancy with regard to the variations seen in Table 1 emphasizes that the interface area is the determinant.

These in vitro results suggest an action of the enzyme at the solvent/water interface and could be a reflexion of a fundamental phenomenon of enzyme action at lipid/water interfaces in the cell, as suggested by Robertson (*8*) and more recently by Danielli and Davies (*9*). This effect probably depends on some special physicochemical property of the bacterial enzyme not shared by the animal enzyme and may involve the concentration and possibly the orientation of the enzyme at the interface. The effect differs from that noted by Schulman (*10*), who attributed the difference in reaction rate in the hydrolysis of various esters by pancreatin to orientation of the substrate molecules at the ester/water interface. Wasteneys and Borsook (*11*) showed that the activity of pepsin in the synthesis of plasteins was increased by the addition of benzene or benzaldehyde. The observation by Doyle (*12*) that *Escherichia coli* glucuronidase can be split into two fragments, (i) an inactive butyl-alcohol-soluble fragment of undefined nature and (ii) a much less active protein fragment, is suggestive of a lipoprotein character for the enzyme and would not be incompatible with the notion of concentration at the solvent-water interface. Finally, in addition to this interface effect observed by us, the nature of the solvent plays an important role, as is seen in the varying activating power of different solvents observed by Gautney, Barker, and Hill and confirmed by us.

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12 October 1959

Characterization of Endogenous Ethanol in the Mammal

Abstract. Ethanol has been isolated from the tissues of several animal species in amounts ranging from 23 to 145 μmole/100 gm of tissue. Intestinal bacterial flora appear to be excluded as a source of this ethanol. Radioactivity from pyruvate-2-C^{14} appeared in ethanol after incubation with liver slices; this finding indicates an endogenous synthesis.

Whether ethanol occurs endogenously in mammalian tissues has been a moot question for years. Although some investigators (*1*) have reported the presence of ethanol in amounts of from 2 to 5 mg per 100 gm of tissue or per 100 ml of plasma, as determined by chemical methods, other investigators (*2*) have questioned this finding on the basis of possible bacterial contamination of the tissues studied or inadequate isolation and assay procedures. This report describes some experiments designed to clarify this question.

Liver, kidney, heart, and skeletal muscles were removed rapidly from animals and homogenized immediately in a one-to-one mixture of ice-cold distilled water or 0.1*M* phosphate buffer at *p*H 7.4 in a Potter-Elvehjem homogenizer. The skeletal and heart-muscle samples were minced prior to homogenization. In some cases the homogenate was heated for 5 minutes in a water bath at 80° to 90°C in a sealed tube and then freeze-dried in a glass lyophilizer. In other cases there was no heating. The lyophilates were kept frozen until it was time to assay them for ethanol. Aliquots of the lyophilate were assayed by spectrophotometric measurement of diphosphopyridine nucleotide (DPN) reduction catalyzed by twice-recrystallized yeast alcohol dehydrogenase (*3*) according to the procedure described by Bonnichsen and Theorell (*4*).

In vitro formation of ethanol was studied in liver slices which were incubated in Warburg flasks in an atmosphere of nitrogen at 38°C; about 300 mg of slices per milliliter of Krebs-Ringer phosphate medium were used. At the end of these experiments, the tissues and medium were prepared for analysis in the manner specified above, except that heating was omitted.

Since a number of alcohols and related compounds act as substrates for yeast alcohol dehydrogenase to varying degrees (*5*), it seemed important to characterize the substrate isolated from tissue as ethanol. The following criteria were used to establish the identity. First, the isolation procedure permits complete recovery of known amounts of ethanol, and the assay is sensitive to 0.1 μmole of ethanol. Second, other possible reactive substrates (*5*) have been assayed under standard experimental conditions and eliminated as contributors to the reduction of DPN in the presence of yeast alcohol dehydrogenase. Third, acetaldehyde has been detected qualitatively as a product of alcohol dehydrogenase activity in the presence of a tissue lyophilate by reaction with sodium nitroprusside and piperidine (*6*), and it has been measured by iodine titration of the bisulfite complex. In two experiments, about 50 percent of the acetaldehyde expected on the basis of the degree of DPN reduction was recovered after distillation of a reaction mixture and iodine titration of aldehyde trapped as the aldehyde-bisulfite complex. Fourth, the 3,5-dinitrobenzoate of ethanol was isolated and was identified (i) by its mobility on paper in 20:80 dioxane: water, R_f=0.08 (*7*), and in 30:70 pyridine:water, R_f=0.77, and (ii) by its behavior on a silicic acid–Super-Cel column (*8*) with and without added authentic ethyl dinitrobenzoate. The chromatographic procedures failed to reveal measurable amounts of the lower alcohols, such as propanol and butanol.

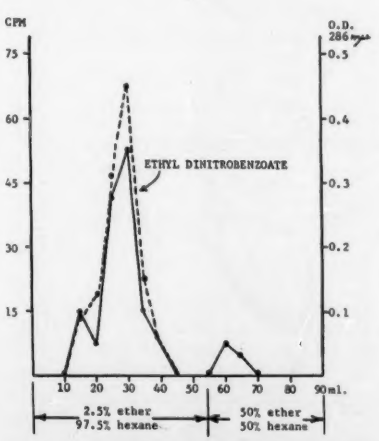

Fig. 1. Chromatography of 3,5-dinitrobenzoates obtained from pyruvate-2-C^{14} incubation with rat-liver slices. Unlabeled ethanol (5 mg) was added as a carrier at the end of 1 hour of incubation. Dimensions of column, 0.5 by 14 cm. Solid line, counts per minute; broken line, optical density of derivative.

Table 1. Concentration of ethanol in mammalian tissues.

Tissue	Concn. of ethanol (μmole per 100 gm of tissue or per 100 ml of plasma)
Rat liver	106
Rat liver (rats maintained on purified diet)	119
Rat plasma	49
Rabbit liver	67
Human liver	145
Rat kidney	23
Rat skeletal muscle	38
Rat heart	106

Although ethanolamine was detected in a low amount in the lyophilate prepared from rat liver, by its reaction with Ninhydrin (*9*), at this level it failed to reduce DPN in the presence of alcohol dehydrogenase under the experimental conditions employed. Furthermore, ethanolamine bisdinitrobenzoate was found to behave differently from ethyl dinitrobenzoate on the silicic acid–Super-Cel column.

After the presence of ethanol in liver had been established, the levels of ethanol in various tissues from several species were determined with yeast alcohol dehydrogenase. These data are presented in Table 1. The highest levels were found in rat liver and heart and in human liver. Since ethanol is distributed in body water (*10*), these differences may reflect in part differences in the ratio of tissue mass to water content. The contribution of intestinal bacterial flora to the observed ethanol levels was studied by feeding eight rats a complete synthetic diet (*11*) and eight rats the same diet supplemented with 2 percent of succinylsulfathiazole to suppress bacterial flora (*12*). After 3 weeks on an ad libitum feeding regime, the two groups were sacrificed and the livers were assayed for ethanol. No significant difference was apparent in the levels of ethanol found in the two groups, and it is therefore unlikely that bacterial metabolites contribute significantly to the formation of endogenous ethanol.

The metabolic origin of this ethanol was next explored. One possible route leading to its formation could involve the participation of pyruvic oxidase and pyruvic acid (*13*). Juni and Heym (*14*) showed that muscle pyruvic oxidase catalyzed the production of some free acetaldehyde. In their system, acetoin appeared as the major product. Under strongly reductive conditions in the presence of alcohol dehydrogenase, free acetaldehyde would be readily reduced to ethanol (*15*). Preliminary results have been obtained which are consistent with the operation of this pathway, although other routes of synthesis are not excluded. The incorporation of pyruvate-2-C^{14} (205,530 count/min per 11.05 μmole) into ethanol was studied in liver slices anaerobically in Krebs-Ringer phosphate medium at *p*H 7.4. After 1 hour, the slices plus the medium were homogenized and lyophilized after the addition of unlabeled carrier ethanol, and the 3,5-dinitrobenzoates were isolated and chromatographed. As shown in Fig. 1, ethyldinitrobenzoate was the principal compound found by silicic acid–Super-Cel chromatography (*8*). It contained essentially all of the radioactivity; this finding corresponds to the formation of 35.7 mμmole of ethanol from pyruvate. Experiments are in progress to obtain further evidence on the mechanism of this synthesis and to investigate the contribution of other possible precursors of endogenous ethanol (*16*).

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28 July 1959

Reciprocal Inhibition as Indicated by a Differential Staining Reaction

Abstract. Neurohistological and neurophysiological studies have shown that the bilaterally represented Mauthner's cells in teleosts are related both structurally and functionally. The VIIIth nerve afferents, as well as the axoaxonal collaterals, display a distribution pattern which supports the concept of polar function of the neuron. Inasmuch as it is possible to alter the staining reaction of both the Mauthner's cells by unilateral stimulation of the entering VIIIth nerve roots, it is proposed that the synaptic endings serve principally as activators and that neuronal excitation or inhibition is determined by the chemical state of the dendrites, the cell body, and the axon hillock region.

In an attempt to relate the structure of the neuron with its function, extensive histological and neurophysiological studies have been made on the bilaterally represented pair of Mauthner's cells which lie in the floor of the medulla oblongata of the teleost. In an earlier report, a differential staining reaction of the various parts of this neuron (dendrites, cell body, and axon hillock region) was described (*1*). At that time it was suggested that this might be indicative of specific intracellular chemical changes characterizing the phenomenon of excitation and inhibition of the neuron.

A new series of studies involving 15 bullheads (ten experimental fish and five controls) has shown that it is possible to induce a differential staining reaction of the two Mauthner's cells. The procedure involved the exposure and stimulation of roots of the VIIIth nerve after craniotomy. Hypothermal anesthesia was used. The VIIIth nerve roots on the right side of five experimental fish were stimulated at threshold level (ten stimulations per second for 1.0 second); the same type of stimulus was applied on the left side in the other five fish. The response to this stimulus was a rapid unilateral flexion of the tail. The brain was removed and processed by a freeze-dehydration technique; this was followed by staining with activated Protargol (*1*). The control fish were treated in the same manner except for the nerve stimulation.

The staining reaction of the Mauthner's cell on the same side as the applied VIIIth nerve stimulation was characterized by deeply stained dendrites and a somewhat lighter cell body, while the axon hillock and the proximal portion of the axon appeared to be an almost translucent lavender. In contrast, the Mauthner's cell contralateral to the applied stimulus stained in an opposite manner, with the den-

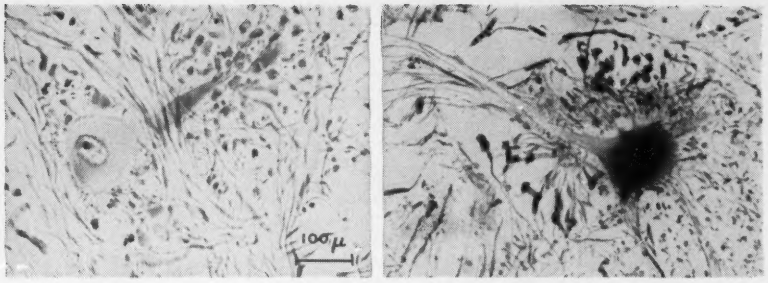

Fig. 1. Photomicrograph of the bilaterally represented Mauthner's cells, showing the differential staining reaction produced by unilateral stimulation of the VIIIth nerve afferents. The cell on the side of the applied stimulus (right) shows deeply stained dendrites and cell body and a lightly colored axonal region. The dendrites and cell body of the contralateral cell (left) stain a light color, while the axonal region is colored a deep purple. The orientation of the photographs is the same as that of the cells in the medulla oblongata of the bullhead. The axon of each cell is directed toward the center and somewhat upward.

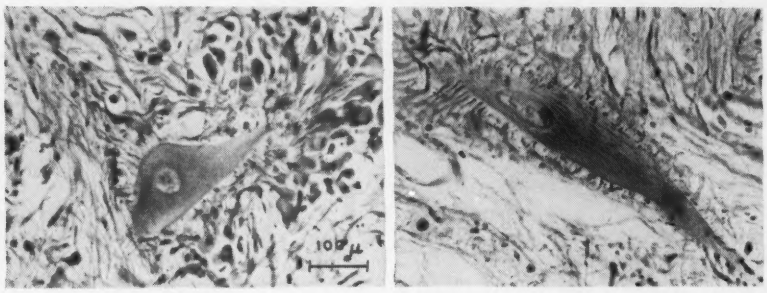

Fig. 2. Photomicrograph of the Mauthner's cells in the control fish. Note the uniformity of the staining reaction of the cytoplasm in contrast to the staining seen in the experimental bullheads. The orientation is the same as in Fig. 1.

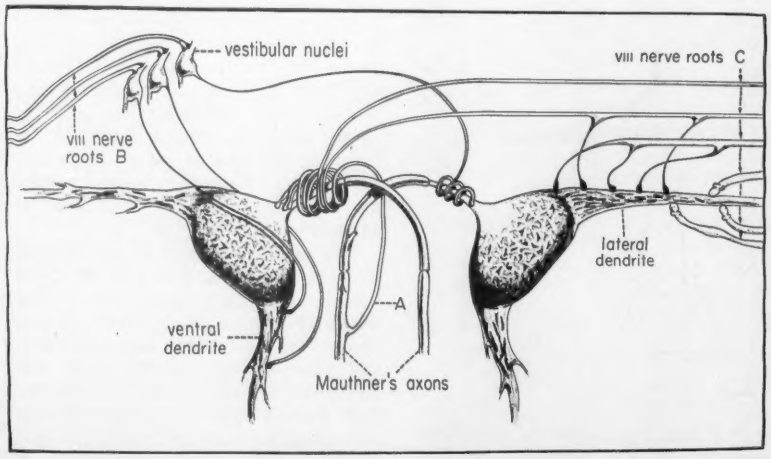

Fig. 3. Schematic representation of VIIIth nerve-Mauthner's cell in a teleost. (*A*) Axon collateral extending from the axon of the "excited" Mauthner's cell to the axon pole of the "inhibited" cell. (*B*) Indirect VIIIth nerve afferents to the vestibular nuclei; these in turn make synaptic contact with the two Mauthner's cells. (*C*) Direct VIIIth nerve afferents which end on the dendrite and cell body of the homolateral Mauthner's cell as well as on the axon pole of the contralateral cell.

drites and cell body colored lavender and the axonal pole of the neuron a deep purple (Fig. 1). Both of the Mauthner's cells in the nonstimulated fish had a rather homogeneous lavender coloration (Fig. 2). In all fish, both experimental and controls, the neuronal elements such as the nucleus appeared to be essentially normal. The surface of the dendrites, the cell body, and the axon hillock region were literally covered with synaptic endings.

In previous neurophysiological experiments it was shown that the observed response of the fish to unilateral stimulation of roots of the VIIIth nerve was a powerful flexion of the tail to one side only, in a one-to-one stimulus-response pattern (*2*, *3*). Also, it was found that bilateral simultaneous stimulation of roots of the VIIIth nerve could not induce the two cells to discharge at the same instant, as was evidenced by recording the evoked potentials from the two Mauthner's axons (*3*).

Histological studies have shown that the distribution of the VIIIth nerve synaptic endings is to the dendrites and cell body of the homolateral Mauthner's cell and to the axon pole of the contralateral cell. This pattern is in accord with the concept of polar function of the neuron, in which it was postulated that the afferent fibers which end on the dendrites and the cell body function to excite neuronal discharge, while those ending on or near the axon hillock serve to inhibit neuronal discharge (*1*, *3*).

A system of axoaxonal collaterals has been found to interconnect the two Mauthner's cells. These branchings arise from the axon of one Mauthner's cell, and after forming a spiral around the proximal part of the axon of the other Mauthner's cell, they end on its axon hillock. These collaterals may function as a feedback loop to augment the direct inhibitory effect of the VIIIth nerve synaptic endings, which also terminate on or near the axon pole of the Mauthner's cell contralateral to the side of their origin (Fig. 3).

These findings of the existence of axoaxonal collaterals which interconnect the two Mauthner's cells and the differential staining reaction of the two cells, which is alterable by afferent fiber stimulation, seem most significant. Inasmuch as the VIIIth nerve afferents are distributed to rather specific regions on the two cells and since it has not been possible to induce both cells to discharge simultaneously even though the entering roots of the VIIIth nerve of both sides are stimulated at the same time, it seems likely that the distinctive cell coloration is indicative of neuronal excitation and inhibition.

It is proposed that in this VIIIth nerve Mauthner's cell system the two cells function as reciprocating units and that the synaptic effect is to alter the intracellular chemical state which results in excitation or inhibition as the case may be. This, of course, implies that the dendrites, the cell body, and the axon pole are of prime functional importance in nervous integration, while the synaptic endings serve as activators rather than as specific excitors or inhibitors (*4*).

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16 September 1959

Orientation of Migratory Restlessness in the White-Crowned Sparrow

Abstract. Individuals of two migratory races of white-crowned sparrows (*Zonotrichia leucophrys*) caged under an open sky showed a pronounced orientation in their night restlessness during normal periods of migration for the species. In August and September 1958 most birds showed a southerly orientation at night; daytime activity was random to somewhat northerly. In April and May 1959 most birds showed a strong northerly orientation at night; daytime activity was random to somewhat southerly (*1*).

Several species of caged passerine birds, which normally migrate at night, exhibit night restlessness (*Zugunruhe*) during the season of migration (*2*). This night activity provides a useful device for investigating the energy requirements of migration in these species (*3*).

In Europe several species of birds have been demonstrated to show a seasonal and predictable orientation with respect to migratory restlessness. These birds apparently navigate by the sun if they are day migrants and by the stars if they are night migrants (*4*).

White-crowned sparrows (*Zonotrichia leucophrys gambelii and Z. l. pugetensis*) captured on their winter range in the vicinity of San Jose, Calif., were kept captive in an outdoor aviary on the roof of the Natural Sciences Building on the campus of San Jose State College in mid-town San Jose. Conditions in the aviary allowed the birds to maintain reasonably natural patterns of seasonal weight change, molt, and gonadal development. Birds captured in early 1958 were first tested in August 1958. Most birds tested in early 1959 had been captured in late 1958 and early 1959.

Our activity-orientation cage is a modification of that used by Kramer (*5*) and is designed for continuous automatic recording of activity. Orientation of restlessness was obtained by placing an individual bird in a circular cage 36 in. in diameter and 10 in. high (Fig. 1) under an open sky. All later tests were made with a 24-in. masonite screen around each cage to block out most surrounding "landmarks." Each cage has a central circular perch surrounding its food and water cafeteria, and has around its periphery eight separate activity-sensitive perches. Each perch occupies just under 45° of the 360° circle. Perches are monitored electrically on remotely located Esterline-Angus (20-pen) recorders. One activity-orientation cage was used in late 1958 and early 1959, and four were in operation as of April 1959.

In April and May (1959), birds which had completed their prenuptial molt and which had gained weight to more than 30 gm (normal weight at other periods is 25 to 27 gm) were active at night. This night restlessness was strongly oriented to the north and northwest (see Table 1). Daytime activity tended to be random or to show a slight southerly orientation. The increasing trend toward a northerly orientation during the first two or three nights in which significant activity occurred suggests that restlessness (i) may develop before a sense of

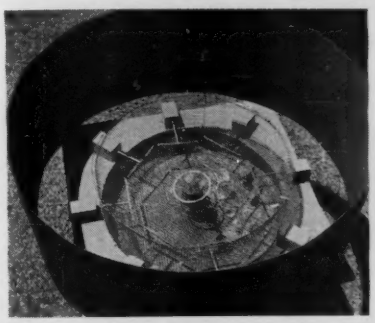

Fig. 1. Activity-orientation cage showing proportions of parts and the position of the 24-in. masonite screen.

Table 1. Numbers of times each directional perch was used by a caged white-crowned sparrow (*Zonotrichia leucophrys gambelii*) by day and by night during the period of development of vernal migratory restlessness. The sparrow was a male (28 gm) captured 5 Feb. 1959 near Gilroy, about 30 miles southeast of San Jose State College. Prenuptial molt was completed about 27 April. Critical weights were as follows: 12 April, 31 gm; 18 April, 32 gm; 25 April, 38.5 gm; and 3 May, 38.5 gm. All nights were partly cloudy except that of 25-26 April, which was cloudy and yielded 0.7 in. of rain.

Date (1959)	Orientation of daylight activity								Orientation of nighttime activity							
	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW	N	NE
23 Apr.	37	45	54	76	61	49	56	51	1	0	5	3	5	2	1	0
24 Apr.	73	109	154	155	148	131	113	109	0	0	0	5	0	0	0	0
25 Apr.	238	183	241	210	203	234	211	167	0	0	2	1	0	4	0	0
26 Apr.	130	385	314	481	390	295	437	220	31	7	13	31	26	28	66	82
27 Apr.	32	68	53	68	53	55	76	41	17	1	6	19	23	199	477	499
28 Apr.	46	55	121	141	41	78	138	55	4	5	7	12	9	58	1620	186
29 Apr.	24	31	105	373	67	52	242	35	10	12	98	57	15	80	1005	73
30 Apr.	16	39	41	88	55	51	66	30	22	6	5	26	11	18	945	135
1 May	25	64	39	84	48	50	59	49	8	2	2	6	6	22	1185	78
Total	621	979	1122	1676	1066	995	1398	757	93	33	138	160	95	411	5299	1053
Percentage	7	11	13	20	12	12	16	9	1	0	2	2	1	6	73	15

orientation has materialized or (ii) may be necessary to permit the development of orientation. The fall-off in the intensity of daytime activity when nocturnal activity becomes strong also appears to be characteristic of individual birds which exhibit the clearest patterns of orientation.

In August, September, and October (1958), birds which had completed their postnuptial molt and which had gained sufficient weight exhibited significant night restlessness. They showed a significant tendency to move toward the south, southeast, or southwest during the hours of darkness when the sky was clear. Daytime activity tended to be random or somewhat northerly in orientation. It should be noted that these birds were already within a few miles (10 to 50) of their natural winter home, and that this would tend to lead to a more diffuse pattern of activity. The greater strength of the northerly orientation in the vernal period than of the southerly orientation in the estival period was to have been expected, for the birds were many hundreds of miles south of their breeding range.

The presence or the absence of the masonite screen seemed to have little effect on the orientation of day or night activity. Rotation of the screened cage in which a bird showed strong orientation of activity revealed some influence of points of reference in the cage. After a 90° rotation, nearly complete correction was accomplished the first night if the night was clear. If, however, the sky was overcast or partly cloudy, correction was not accomplished as readily.

These results and additional preliminary findings from manipulation of daily photoperiods suggest that the activity-orientation cage provides a useful tool for the study of the physiology of the orientation of migration with birds of the genus *Zonotrichia*.

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24 August 1959

State of Dynamic Equilibrium in Protein of Mammalian Cells

Abstract. Labeled strain L cells in suspension tissue culture showed no degradation of protein when maintained in logarithmic growth. Although the protein of these cells was not in dynamic equilibrium, the conclusions cannot be transferred to the intact mammalian organism.

The concept of "dynamic equilibrium" of cellular proteins has been accepted since the investigations of Schoenheimer and his colleagues (*1*). Recently this concept has been challenged by workers studying adaptive enzyme formation in bacteria (*2*). They found that preformed cellular protein did not contribute to a newly induced adaptive enzyme. Furthermore, once an adaptive enzyme was formed and the inducer was removed, that particular enzyme did not incorporate labeled amino acid into its structure. Similar results on the lack of protein turnover were obtained with yeast cells maintained in logarithmic growth (*3*). However, using mammalian tissue culture cells, one group found a turnover of 0.85 to 1.0 percent per hour (18.5 to 21.3 percent per day) (*4*), and other investigators reported a turnover of 12.9 percent per day (*5*).

It is now possible to grow mammalian cells in a manner very similar to that in which bacteria are grown (*6*). By maintaining L cells in logarithmic growth, it has been shown that both deoxyribonucleic acid and ribonucleic acid undergo no turnover in rapidly growing cultures (*7*). These facts have made it desirable to reinvestigate protein degradation in mammalian cells maintained in strict logarithmic growth.

Strain L cells were grown in 250-ml erlenmeyer flasks placed on a rotary shaker in an incubator maintained at 37.5°C. Each flask contained cells (200,000 per milliliter), Eagle's basal medium (72 ml), horse serum (8 ml), penicillin (100 units/ml), streptomycin (100 μg/ml), and leucine-1-C^{14} (3 to 4 $\times$ 10^6 counts per culture, specific activity 1.4 mc/mm) (*8*).

The culture was allowed to grow for 3 days until a high cell number (1 $\times$ 10^6 cells per milliliter) was reached. All counts were made in duplicate on a standard hemocytometer. At this time, one-third of the cells were removed and washed 3 times by centrifugation in 50 ml of Krebs-Ringer phosphate buffer. After resuspension in fresh unlabeled medium, the cells again grew logarithmically and showed a generation time of 26 hours. During this time the cells eliminated almost all the free labeled amino acid from their free intracellular pool. At the end of 3 days, 20 ml of this culture, containing approximately 1.5 $\times$ 10^6 cells per milliliter, was poured into a new flask containing 60 ml of fresh medium. This fresh medium had previously been warmed to 37.5°C, and the *p*H adjusted to 7.1. It was essential that the transfer be completed quickly, carefully, without change in *p*H or temperature, and without other disturbances which might result in compensatory equilibratory reactions and interfere with the delicate autoregulatory processes associated with logarithmic growth of the cells.

Aliquots (5 ml) were removed daily from those cultures maintaining a generation time of 26 hours. The cells were washed three times in 15 ml of Krebs-Ringer phosphate buffer solution by centrifugation at 3000 rev/min. The protein of the centrifuged cells was precipitated with 5-percent cold trichloroacetic acid. After centrifugation, the trichloroacetic acid in the protein-free supernatant was extracted three times with ether, and the remainder, containing the free amino acid pool, was plated on planchets. The trichloroacetic acid precipitate, containing the cellular protein, was extracted twice with ethanol: ether (1:1) at 48°C for 45 minutes and once with hot trichloroacetic acid at 90°C for 1 hour; it was washed with ether and plated on previously weighed planchets. All planchets were counted in duplicate in a windowless gas-flow counter and corrected for self-absorption when necessary.

The results (Table 1) show that the counts per minute in the protein obtained from 1 ml of culture fluid remained constant during the period of the experiment, regardless of the large increase in cell number and in cell weight, and indicate that turnover of radioactive leucine during this period was negligible. It should be emphasized that during this period the cells were suspended in medium containing no labeled leucine and were in logarithmic growth. This is most consistent with the hypothesis that there is no degradation of cellular protein during periods of active growth. Other evidence concerning the lack of protein breakdown was found in the fact that labeled leucine was not found either in the extracellular or in the intracellular free amino acid pool except in negligible quantities. There was a possibility that cellular protein could be degraded and resynthesized without passing through the free pool, but it seemed unlikely that this could have occurred without any appreciable loss of labeled leucine from the cellular protein to the large volume of intra- and extracellular fluid. The relatively enormous quantity of unlabeled leucine present in the intracellular and extracellular fluid would be expected to act as a "trap" for any free labeled leucine degraded and separated from the protein. Oxidative and other degradative reactions did not occur to any appreciable extent. The experiments were not started until after 3 days of preliminary incubation in unlabeled medium, which insured that the amount of label in the free amino acid pool was negligible. It is possible that some proteins which had a very rapid turnover lost their label during this period, and that the constant daily counts represented only the stable residual proteins.

Table 1. Degradation of protein in strain L cells in rapid growth.

Experiment No.	Day No.	No. of cells per ml $\times 10^3$	Cell protein (μg/ml)	Cell protein (count/min ml*)	Cellular free pool (count/min ml†)	Extracellular medium (count/min ml‡)
1	1	250	75	1633	4	20
1	2	640	210	1630	5	31
1	3	1300	450	1600	7	29
1	4	2000	650	1623	6	28
2	1	500	165	1781	9	15
2	2	900	300	1772	5	15
2	3	1700	540	1714	5	20
3	1	200	60	884	2	25
3	2	380	130	884	0	23
3	3	800	280	847	0	29
3	4	1700	560	880	0	24
4	1	420	138	860	3	31
4	2	730	248	850	2	22
4	3	1600	527	840	4	26
5	1	350	120	841	4	30
5	2	620	200	864	0	37
5	3	1200	396	821	5	33

* Count/min in trichloroacetic acid precipitate of washed cells from 1 ml of culture fluid. † Count/min in trichloroacetic acid supernatant of washed cells from 1 ml of culture fluid. ‡ Count/min in 1 ml of culture fluid after removal of cells. These counts represent contaminating extracellular label carried over in the transfer of medium and cells, as previously described, into the final experimental subculture.

These experiments, however, provide evidence that mammalian tissue culture cells maintained in logarithmic growth behave in a manner similar to the behavior of bacteria and yeasts and exhibit no "dynamic equilibrium." It should be strongly emphasized that these cultures are maintained under strictly regulated controlled conditions, and that cultures grown under conditions that allow even minor alterations in the environment for very short periods of time show large fluctuating compensatory changes in the amino acid pattern. The wide range of protein turnover values already reported (12.9 to 21.3 percent per day) (*4*, *5*) may well indicate the variation to be expected when extreme precautions are not taken to avoid equilibratory reactions.

The relevance of these and of previous experiments (*2*, *3*) to the conditions existing in the intact mammalian organism is uncertain. The cells of most organs, except perhaps skin, hematopoietic tissue, and intestinal and urinary tract mucosa, are not in constant division and thus might not be expected to show results similar to cells maintained in logarithmic growth in culture. An active "dynamic equilibrium" has been found in the proteins of "resting" cultures of yeasts, bacteria, and mammalian cells. However, we feel that the term *resting culture* is a euphemism for "dying culture." These cells undergo vast visible and chemical changes in a matter of hours, or at most of days, and are in no way comparable to cells of the liver, heart, kidney, and brain. These latter cells, with negligible mitotic indices, exist for weeks, months, or years without apparent change.

These experiments support the hypothesis that preformed protein does not incorporate new amino acids into its internal structure. We would speculate that in cells whose energies are wholly directed toward self-replication, there is no dynamic equilibrium, while in cells with other, various obligations, and with shifting substrates and changing environments, there is constant degradation and resynthesis of protein to meet these varying demands. In this sense there probably exists a very real dynamic equilibrium (*9*).

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9. This investigation was supported by a grant [C2928(C2)] from the U.S. Public Health Service.

26 August 1959

Mosses as Possible Sources of Antibiotics

Abstract. An examination of 12 species of mosses has indicated that three produce substances capable of inhibiting the growth of various bacteria and other fungi. The method of extraction included several solvents. The extracts were not consistent in their antagonistic activity against the various species of microorganisms, nor were those that displayed antibiotic action always effective against the same organisms. Results indicate unstable products as well as physiological variation in the mosses.

In recent years many possible sources of antibiotics have been explored. These include flowering plants as well as cryptogams such as algae and lichens, in addition to the more highly advertised fungi. Examination of the literature reveals few cases of parasitism of fungi upon bryophytes. Thus it has been felt that assay might reveal some special substance which would prevent the growth of parasites. The suggestion that bryophytes might contain such substances has been made by numerous bryologists.

Earlier investigations have shown that certain products of *Sphagnum portoricense, S. strictum, Conacephalum conicum,* and *Dumortiera hirsuta* have inhibitory powers (*1*), although *Conacephalum conicum* had previously been reported as producing little or no inhibitory substance (*2*).

The mosses that were tested are: *Hygroamblystegium irrigum, Bryum argenteum, Pohlia wahlenbergii, Grimmia wrightii, Anomodon rostratus, Orthotrichum rupestre, Ceratodon stenocarpus, Bryum pallescens, Hedwigia albicans, Sphagnum* sp., *Mnium cuspidatum,* and *Polytrichum* sp. All except the last three were collected locally.

Two hundred grams of whole moss were washed by hand, rinsed in distilled water, and divided into 40-gram aliquots. Each aliquot was then immersed in 70 ml of a different extraction solvent and macerated in a Waring blender. The following extraction solvents were used: distilled water, 95-percent ethanol, acetone, chloroform, and 0.9-percent NaCl solution. After 5 minutes' blending at high speed, each extract was filtered through four layers of cheesecloth, and the filtrate was centifuged. The supernatant and residue were saved for testing. A special method designed from a technique employed by Carlson and Douglas (*3*) was used in preparing the 0.9-percent NaCl extract for testing. The supernatant was divided evenly among three separate test tubes. An equal volume of 1.5-percent H_2SO_4 was added to the first test tube. To the second was added an equal volume of a buffer solution (*p*H 9; 2-percent $Na_2P_2O_7$), and the solution in tube No. 3 had nothing added. The three tubes were placed in the refrigerator for 24 hours. Before testing, the 1.5-percent H_2SO_4 mixture was neutralized with 4-percent NaOH.

The extracts were tested by a modification of the method used by Lucas *et al.* (*4*). The test organisms were grown in tryptose broth (Difco) with the exception of *Phytomonas phaseoli,* which was grown in nutrient broth. The corresponding agar medium was used in the plate examination.

Plates for the examination of the extracts were prepared by flooding the agar surface with 1 ml of an 18 hour broth culture of the test organism and allowing them to stand for 10 minutes. The plates were dried by draining off the excess broth and inverting the plates at a 45° angle with the tops removed. The plates remained in this position for 15 minutes. The discs were prepared by immersing filter paper discs with a 6-mm diameter in the unsterilized extract for 5 seconds. The discs were then dried at room temperature and placed on the inoculated agar surface of the assay plates. These plates were incubated at a suitable temperature for the usual "overnight" period, which did not exceed 18 hours. Zones of inhibition, where found, were recovered as the diameter of the zone and disc. When inhibition occurred with the 4 screening organisms, antibiotic activity of the extract was subsequently tested on six other organisms.

Of the mosses tested, only three showed positive evidence of inhibition. Two of these, *Anomodon rostratus* and *Orthotrichum rupestre,* are shown in Table 1. The supernatant portion of the 95-percent ethanol extract of the third, *Mnium cuspidatum,* produced a 12-mm zone against *Micrococcus flavus* and a 10-mm zone against *Streptococcus pyogenes.* A second test of *Orthotrichum rupestre* collected from the same station but 6 weeks later than the original collection gave results only with the supernatant portion of distilled water in which a 23-mm zone was produced against *Streptococcus pyogenes* and with the supernatant portion of 95-percent ethanol in which a 10-mm zone was produced against *Candida albicans,* a 10-mm zone against *Micrococcus flavus,* and a 16-mm zone against *M. rubens.* Evidence that several compounds, rather than a single one, are involved is shown by the fact that extracts of the same moss species by different solvents gave different results (*5*).

Table 1. Results of screening various moss extracts for antibiotic activity against nine microorganisms. Solvents: A, distilled water; B, 95-percent ethanol; C, acetone; D, chloroform; E, 0.9-percent NaCl solution; E_1, 0.9-percent NaCl extract in 1.5-percent H_2SO_4; E_2, 0.9-percent NaCl extract in *p*H 9 buffers. S, supernatant; R, residue. Numbers denote radial zone diameters in millimeters; P, partial inhibition; x, no test.

	Anomodon rostratus							*Orthotrichum rupestre*						
	A	B	C	D	E	E_1	E_2	A	B	C	D	E	E_1	E_2
	S R	S R	S R	S R	S R	S R	S R	S R	S R	S R	S R	S R	S R	S R
Staphylococcus aureus	0 0	0 0	0 8	9 9	8 0	0 x	0 x	9 P	11 0	9 9	8 0	8 0	0 x	0 x
Salmonella pullorum	P 0	0 11	0 8	8 7	0 0	8 x	0 x	0 0	0 0	0 0	0 0	0 0	0 x	0 x
Phytomonas phaseoli	0 0	0 8	9 8	9 9	8 10	9 x	0 x	0 0	P 0	10 9	8 0	0 0	0 x	0 x
Candida albicans	0 0	0 0	0 0	0 0	0 0	0 x	0 x	8 8	9 0	10 0	0 0	0 8	8 x	8 x
Salmonella paratyphi	0 0	0 0	0 0	0 0	0 0	0 x	0 x	13 0	10 0	10 0	8 9	9 0	9 x	8 x
Micrococcus flavus	0 0	10 0	0 0	0 0	0 0	0 x	0 x	9 0	9 0	10 0	8 0	0 8	0 x	0 x
Shigella flexneri	0 0	P 0	P 0	0 0	0 0	0 x	0 x	9 0	10 0	9 0	0 0	0 0	8 x	8 x
Micrococcus rubens	0 0	0 0	0 0	0 0	0 0	0 x	0 x	0 0	P 0	0 0	0 0	0 0	0 x	0 x
Streptococcus pyogenes	0 0	P 0	P 0	0 0	0 0	0 x	0 x	P 0	P 0	P 0	0 0	0 0	0 x	0 x

Of the mosses tested, only three showed positive evidence of inhibition. Two of these, *Anomodon rostratus* and *Orthotrichum rupestre,* are shown in Table 1. The supernatant portion of the 95-percent ethanol extract of the third, *Mnium cuspidatum,* produced a 12-mm zone against *Micrococcus flavus* and a 10-mm zone against *Streptococcus pyogenes.* A second test of *Orthotrichum rupestre* collected from the same station but 6 weeks later than the original collection gave results only with the supernatant portion of distilled water in which a 23-mm zone was produced against *Streptococcus pyogenes* and with the supernatant portion of 95-percent ethanol in which a 10-mm zone was produced against *Candida albicans,* a 10-mm zone against *Micrococcus flavus,* and a 16-mm zone against *M. rubens.* Evidence that several compounds, rather than a single one, are involved is shown by the fact that extracts of the same moss species by different solvents gave different results (*5*).

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5. This study was supported in part by a research grant from the National Institute of Allergy and Infectious Diseases, U.S. Public Health Service.

14 September 1959

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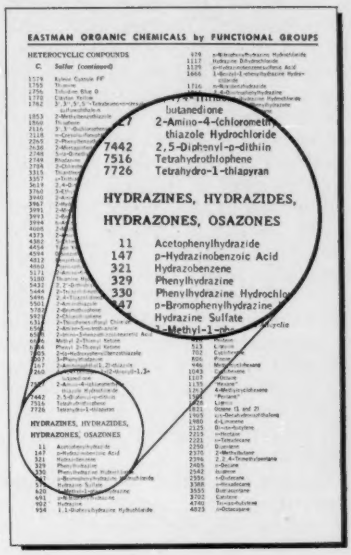
EASTMAN ORGANIC CHEMICALS by FUNCTIONAL GROUPS

HETEROCYCLIC COMPOUNDS

C. Sulfur (continued)

butanedione

2-Amino-4-chloromethyl thiazole Hydrochloride

7442 2,5-Diphenyl-p-dithiin

7516 Tetrahydrothiophene

7726 Tetrahydro-1-thiapyran

HYDRAZINES, HYDRAZIDES, HYDRAZONES, OSAZONES

11 Acetophenylhydrazide

147 p-Hydrazinobenzoic Acid

321 Hydrazobenzene

329 Phenylhydrazine

330 Phenylhydrazine Hydrochlo

47 p-Bromophenylhydrazine

Hydrazine Sulfate

1-Methyl-1-ph

HYDRAZINES, HYDRAZIDES, HYDRAZONES, OSAZONES

11 Acetophenylhydrazide

147 p-Hydrazinobenzoic Acid

321 Hydrazobenzene

329 Phenylhydrazine

902 Hydrazine

934 1,1-Diethylhydrazine Hydrochloride

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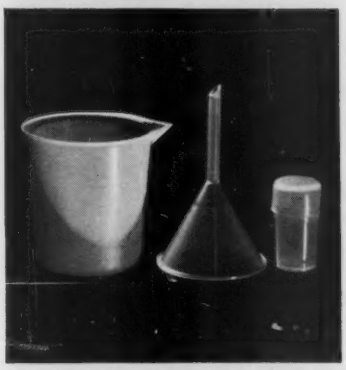

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Since (until now) we had spent less on advertising this film than we spend on lollipops for the kids at the annual office Christmas party, the product is little known outside of cinetheodolite and hydrogen bubble-chamber circles. The inquirer gets the satisfaction of having been tipped off on something special; and the antique, oddly militant name "Shellburst" sticks in the mind. Thus (and this makes strong admen blush) *Kodak Linagraph Shellburst Film* has turned into one of our most prosperous technical products. This is the black-and-white film for photographing a tiny little speck in a great big sky.

Now we wish to announce an upward shove in *Shellburst* performance. The spectral sensitivity peak has been shifted from 650mμ to 680mμ. This decision was reached at the cost of a vast number of man-hours, not only in the laboratory but out on deserts and hazy hillsides. In the course of these labors, good optical reasons turned up for peaking at 680mμ instead of pushing out to the infrared.

Along with the extension of red sensitivity, the new *Shellburst* has been endowed with half again as much speed for the same graininess, and a hardening of the emulsion to permit speedy hot processing, a significant improvement in acutance that is particularly prominent at high densities.

With Gray Base it comes in 16mm and 35mm. "Gray Base" refers to an 0.22 density introduced into the support for antihalation purposes. With Clear Base it comes as 35mm and 70mm. This is usually preferred for use in instruments that record timing data, fiducial marks, etc., through the back of the film. For processing recommendations and the names of dealers who sell it, write Eastman Kodak Company, Photorecording Methods Division, Rochester 4, N. Y.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Kodak
TRADE MARK

Meetings

Plant Growth Regulation

The fourth International Conference on Plant Growth Regulation was held at the Boyce Thompson Institute for Plant Research, Yonkers, N.Y., 10–14 August. The conference was sponsored jointly by the Institute, the New York Botanical Garden, and the Brooklyn Botanic Garden. Previous international conferences on growth regulators have been held at Wye College in 1955, at the University of Wisconsin in 1949, and in Paris in 1937 under the auspices of the League of Nations. The conference was attended by 126 invited participants from 17 countries. The program was coordinated with the ninth International Botanical Congress, held at Montreal, Canada, 19–29 August. Financial assistance was obtained from the Rockefeller Foundation, the National Science Foundation, and 15 industrial concerns interested in agricultural chemicals.

The first day was devoted to naturally-occurring plant growth substances; the second, to the gibberellins; and the third and fourth to the synthetic auxins and other plant growth substances. In addition to the scheduled papers, there was ample time for discussion at each session. The papers presented and the remarks made during the discussion periods will be published in book form by the Iowa State College Press. Copies will be sent to each participant and will be available to others at a nominal cost.

Among the outstanding new discoveries revealed at the conference was the isolation of a new class of auxins from Maryland Mammoth tobacco by D. G. Crosby and A. J. Vlitos. A ton of tobacco leaves and growing tips yielded about 10 mg of active chemicals. One was identified as 1-docosanol, the other is a long-chain fatty acid not fully characterized as yet. Bruce Stowe also presented data showing the growth-promoting action of long-chain aliphatic compounds.

This was the first international growth conference at which the gibberellins were discussed. The Japanese scientists who did much of the early work on the gibberellins, T. Hayashi, J. Kato, and Y. Sumiki, took part in the conference. P. W. Brian, of the Akers Research Laboratories in England, who was instrumental in drawing the attention of the Western world to the Japanese work on gibberellins, reported on new developments from his laboratory. Evidence indicating the probable widespread occurrence of gibberellin-like substances in plants was presented by C. A. West.

New concepts on the relation be-

tween structure and auxin activity, with special reference to requirements for reaction with the necessary binding sites, were discussed in separate papers by K. V. Thimann and J. van Overbeek.

A feature of the conference was a memorial dinner in honor of the late P. W. Zimmerman. It was in his laboratory at the Boyce Thompson Institute, in cooperation with his associate, A. E. Hitchcock, that 2,4-D was first found to have marked effects on plant growth and development. Indolebutyric acid and 1-naphthaleneacetic acid were also first investigated as growth regulants by Zimmerman and Hitchcock. Extensive investigations by these authors were also carried out with derivatives of benzoic acid and a variety of substituted aryloxyacetic acids, in addition to 2,4-D.

Major addresses at the conference were given by William J. Robbins, director emeritus of the New York Botanical Garden, who spoke at the memorial dinner for P. W. Zimmerman on expanding concepts of plant growth regulation, and by James Bonner of California Institute of Technology, who delivered an address on the probable future of auxinology.

The day after the scientific sessions of the conference ended, the participants were taken on a chartered boat around Manhattan Island, where they had an opportunity to meet members of the botany departments of Columbia and Rutgers universities and staff members of the three sponsoring institutions who were not directly interested in plant growth substances and, therefore, were not participants in the scientific sessions.

George L. McNew, managing director of the Boyce Thompson Institute, was chairman of the organizing committee for the conference, and A. J. Vlitos, who originally suggested that such a conference be held, served as secretary. Vlitos, formerly at the Institute, is now with Caroni Ltd., in Trinidad.

LAWRENCE P. MILLER
Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York

Forthcoming Events

February

1–4. American Soc. of Heating, Refrigerating and Air Conditioning Engineers, semi-annual, Dallas, Tex. (Miss J. I. Szabo, ASHRACE, 234 Fifth Ave., New York 1.)

1–4. Instrument-Automation Conf., Houston, Tex. (Director, Technical and Educational Services, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

1–5. American Inst. of Electrical Engi-

neers, winter general, New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

1–5. Clinical Cong. of Abdominal Surgeons, Miami Beach, Fla. (CCAS, 633 Main St., Melrose 76, Mass.)

2–4. Haemopoiesis—Cell Production and Its Regulation, Ciba Foundation symp. (by invitation only), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

2–4. Society of the Plastics Industry (Reinforced Plastics Div.), Chicago, Ill. (W. C. Bird, SPI, 250 Park Ave., New York 17.)

3–5. Military Electronics, IRE winter conv., Los Angeles, Calif. (G. B. Knoob, Motorola, Inc., Military Electronics Div., 1741 Ivar Ave., Hollywood 28, Calif.)

3–6. American College of Radiology, New Orleans, La. (W. C. Stronach, 20 N. Wacker Dr., Chicago 6.)

3–6. Parathyroid Research, symp., Houston, Tex. (R. V. Talmage, Dept. of Biology, Rice Inst., Houston.)

4–6. American Soc. for Metals, San Francisco, Calif. (R. Huggins, ASM, Stanford Univ., Stanford, Calif.)

4–6. Congress on Administration, 3rd annual, Chicago, Ill. (R. E. Brown, American College of Hospital Administrators, 840 N. Lake Shore Drive, Chicago 11.)

5. Parenteral Drug Assoc., New York, N.Y. (H. E. Boyden, PDA, 4865 Stenton Ave., Philadelphia 44, Pa.)

7–9. Congress on Medical Education and Licensure, Chicago, Ill. (CMEH, AMA, 535 N. Dearborn St., Chicago 10.)

7–10. Radioactive Isotopes in Clinical Medicine and Research, 4th intern. symp., Bad Gastein, Austria. (R. Höfer, 2nd Medical Univ. Clinic, 13 Garnisongasse, Vienna 1X, Austria.)

10–11. Gas Cooled Reactor, symp., Philadelphia, Pa. (F. L. Jackson, Franklin Inst., Philadelphia, Pa.)

10–12. American Acad. of Occupational Medicine, Williamsburg, Va. (L. B. Shone, Bureau of Medicine and Surgery, Navy Dept., Washington 25.)

10–12. Solid States Circuit Conf., Philadelphia, Pa. (T. R. Finch, Bell Telephone Laboratories, Murray Hill, N.J.)

10–13. National Assoc. for Research in Science Teaching, 33rd annual, Chicago, Ill. (C. M. Pruitt, Univ. of Tampa, Tampa, Fla.)

10–13. National Soc. of College Teachers of Education, Chicago, Ill. (E. J. Clark, Indiana State Teachers College, Terre Haute.)

11. Protein and Amino Acid Requirements of Swine, Chicago, Ill. (J. T. Sime, Assoc. of Vitamin Chemists, Evaporated Milk Assoc., 228 N. La Salle St., Chicago 1.)

11–13. Society of Univ. Surgeons, Minneapolis, Minn. (B. Eiseman, 4200 E. Ninth Ave., Denver 20, Colo.)

14–18. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New York, N.Y. (E. O. Kirkendall, AIME, 29 W. 39th St., New York 18.)

16. Astronomical Soc. of the Pacific annual, San Francisco, Calif. (S. Einarsson, Leuschner Observatory, Univ. of California, Berkeley 4.)

18–19. Chemical Inst. of Canada (Protective Coatings Div.), Toronto, Ont., and Montreal, Que., Canada. (Scientific Liaison Office, National Research Council, Sussex Drive, Ottawa, Canada.)

18–20. National Soc. of Professional Engineers, winter, Wichita, Kan. (P. H. Robbins, NSPE, 309 Bancroft Bldg., Univ. of Nebraska, Lincoln.)

21–24. American Inst. of Chemical Engineers, Atlanta, Ga. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

22–25. Technical Assoc. of the Pulp and Paper Industry, annual, New York, N.Y. (J. Winchester, TAPPI, 155 E. 44 St., New York 17.)

22–4. Scientific Management, 12th intern. cong., Sydney and Melbourne, Australia. (C. M. Gray, Federal Council of the Australian Inst. of Management. Western House, 83 William St., Melbourne, C.1, Victoria, Australia.)

24–26. Biophysical Soc., 4th annual, Philadelphia, Pa. (O. H. Schmitt, Biophysical Soc., Chairman, Program Committee, Univ. of Minnesota, Minneapolis.)

25–27. American Orthopsychiatric Assoc., Chicago, Ill. (Miss M. F. Langer, 1790 Broadway, New York 19.)

25–27. Cell Physiology of Neoplasia (14th annual symp. on fundamental cancer research), Houston, Tex. (Editorial Office, Univ. of Texas M. D. Anderson Hospital, Texas Medical Center, Houston 25.)

26. Highway Geology, 11th annual

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Residence Address.....

City..... Zone..... County..... State.....

Age..... ☐ Single ☐ Married ☐ Male ☐ Female

Occupation.....

Location of Car (if different from residence address).....

Is car principally kept and used on a farm or ranch?.....

Yr.	Make	Model (Dlx., etc.)	Cyl.	Body Style	Purchase Date Mo. Yr.	☐ New ☐ Used

1. (a) Days per week car driven to work?..... One way distance is.....miles.
(b) Is car used in any occupation or business? (Excluding to and from work) ☐ Yes ☐ No

2. Additional male drivers under age 25 in household at present time:

Age	Relation	Married or Single	% of Use

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symp., Tallahassee, Fla. (W. F. Tanner, Geology Dept., Florida State Univ., Tallahassee.)

28–5. American College of Allergists, Miami Beach, Fla. (E. Bauers, 2160 Rand Tower, Minneapolis 2, Minn.)

29–3. American College of Surgeons, Boston, Mass. (H. P. Saunders, 40 E. Erie St., Chicago, Ill.)

29–4. Pittsburgh Conf. on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Pa. (L. P. Melnich, U.S. Steel Corp., Monroeville, Pa.)

March

3–5. American Acad. of Forensic Sciences, Chicago, Ill. (W. J. R. Camp, AAFS, 1853 W. Polk St., Chicago 12.)

4–6. National Wildlife Federation, Dallas, Tex. (C. H. Callison, 232 Carroll St., NW, Washington 12.)

6–13. American Otorhinologic Soc. for Plastic Surgery, Miami Beach, Fla. (J. G. Gilbert, 75 Barberry Lane, Roslyn Heights, N.Y.)

7–9. Wildlife Management Inst., Dallas, Tex. (C. R. Gutermuth, 709 Wire Bldg., Washington 5.)

7–11. American Soc. of Civil Engineers, New Orleans, La. (E. S. Kirkpatrick, ASCE, 33 W. 39 St., New York 18.)

10. Recent Developments in Poultry Nutrition (Assoc. of Vitamin Chemists), Chicago, Ill. (J. T. Sime, Director of Research, Evaporated Milk Assoc., 228 N. La Salle St., Chicago 1.)

13–14. American Otological Soc., Miami Beach, Fla. (L. R. Boies, University Hospital, Minneapolis 14.)

14–16. American Railway Engineering Assoc., annual conv., Chicago, Ill. (N. D. Howard, AREA, 59 E. Van Buren St., Chicago 5.)

14–17. Positive Health of Older People, forum, Miami Beach, Fla. (A. Mallach, National Health Council, 1790 Broadway, New York 19.)

15–16. American Broncho-Esophangological Assoc., Miami Beach, Fla. (F. J. Putney, 1712 Locust St., Philadelphia 3.)

15–21. Nondestructive Testing, 3rd intern. conf., Tokyo and Osaka, Japan. (S. Ishizaka, Scientific Attaché, Embassy of Japan, 2514 Massachusetts Ave., NW, Washington 8.)

17. Congress for Pharmacists, 2nd annual, Jamaica, N.Y. (Congress for Pharmacists, Public Relations Office, St. John's Univ., Jamaica 32.)

17–19. American Radium Soc., conf., San Juan, Puerto Rico. (ARS, 635 East Union, Pasadena, Calif.)

17–19. Blood Platelets, intern. symp. (by invitation only), Detroit, Mich. (Miss S. A. Johnson, Henry Ford Hospital, Detroit 2.)

17–20. International Assoc. for Dental Research, Chicago, Ill. (D. Y. Burrill, Northwestern Univ. Dental School, 311 E. Chicago Ave., Chicago 11.)

18–19. American Laryngological Assoc., Miami Beach, Fla. (L. Richards, Massachusetts Inst. of Technology, Cambridge 39.)

20–23. American Assoc. of Dental Schools, Chicago, Ill. (R. Sullen, 840 N. Lake Shore Drive, Chicago 11.)

(See issue of 18 December for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

■ PULSE GENERATOR, completely transistorized, supplies 15-volt positive and negative pulses with separately controlled amplitudes. Pulse width is variable from 0.5 to 100 μsec with rise time less than 0.1 μsec. Repetition rate is continuously variable between 20 and 5000 pulses/sec. Output pulse delays up to 100 μsec and anticipation up to 10 μsec relative to sync output are included. (Solidyne, Dept. Sci272, 7460 Girard Ave., La Jolla, Calif.)

■ CURRENT-REGULATED POWER SUPPLY furnishes 0 to 2.5 amp in four overlapping ranges. Voltage range is 0 to 300 volts. Regulation for 10 percent change in load impedance or line voltage is 0.2 percent in the current range 0.2 and 2.5 amp. Ripple is 0.2 percent (max.) peak to peak. Input power requirement is 208 volts, three phase, 60 cy/sec, and 1.5 kva, with additional 0.5 kva in one phase. (Applied Radiation Corp., Dept. Sci273, 2404 N. Main St., Walnut Creek, Calif.)

■ CHROMATOGRAM SCANNER draws a curve of color density as a function of distance scanned along a paper strip. Simultaneously, the curve is integrated and a second pen draws saw-tooth marks whose number is proportional to the concentration of each component separated on the strip. A balancing cam is used to make results linear with concentration. Other cams are available to present output linear in percent transmission or in optical density. (Beckman Instruments Co., Spinco Div., Dept. Sci282, Stanford Industrial Park, Palo Alto, Calif.)

■ A-C VOLTMETER, model 403A, is a transistorized, battery-operated instrument with a frequency range 1 cy to 1 Mcy/sec. Voltage is measured in 12 ranges from 1 mv full scale to 300 volts full scale. Accuracy is ± 3 percent from 5 cy to 500 kcy/sec, and ± 5 percent over the remainder of the range. Noise is less than 50μv. Battery life is 400 hr. (Hewlett Packard Co., Dept. Sci283, 275 Page Mill Rd., Palo Alto, Calif.)

■ VACUUM FURNACE, model 59-TA, for tensile and creep testing, provides temperatures to 4000°F. The tubular furnace consists of a tantalum heating element surrounded by tantalum and molybdenum radiation shields, water-cooled tank and bellows assemblies,

tantalum plate and rod electrode assembly, vacuum pumping and gaging ports, and auxiliary components. Operating power is 14 volts, 1600 amp. Over-all dimensions are 44 in. high by 11 in. in diameter. (Marshall Products Co., Dept. Sci287, 270 W. Lane Ave., Columbus 2, Ohio.)

■ NOISE GENERATOR, model NG 1000A, provides random noise with Gaussian amplitude distribution within ±2 percent probability from 2 to 98 percent probability and with frequency spectrum variable over a wide range. An electronic metering circuit reads directly r.m.s. and mean value of either generated noise or noise on any variable in analog computer simulation. Output voltage is variable from 0 to 6 volts for the widest band width shaping filter and 0 to 1 volt for the narrowest filter. (GPS Instrument Co., Dept. Sci291, 180 Needham St., Newton, Mass.)

■ SIGNAL ANALYZER permits measurement of amplitudes from 300 cy to 400 kcy/sec. The instrument uses the heterodyne principle and highly selective crystal filters. Metering circuits indicate levels from −80 to +32 dbm with accuracy said to be ±0.5 db. (Railway Communications Inc., Dept. Sci308, 9351 E. 59 St., Raytown 33, Mo.)

■ LOW-FREQUENCY OSCILLATOR, type 1305A, covers frequencies between 0.01 and 1000 cy/sec. The output is continuously variable in phase and is calibrated from 0 to 360 deg. Three- and four-phase outputs are also available. Accuracy of output phase is ±0.5 deg for angles less than 10 deg. Maximum error is ±3 deg at higher phase angles. Small phase differences can be measured at any point with accuracy ±0.25 deg. Output voltage is indicated. (General Radio Co., Dept. Sci286, West Concord, Mass.)

■ LEAK DETECTOR of mass spectrometer type is a helium-sensitive instrument capable of detecting a leak rate of 10^{-13} standard cm^3/sec with 10-percent deflection of an output meter and a signal-to-noise ratio of 1 or better. Response time is less than 2 sec for ⅔ of final response. Seven ranges provide full-scale rates from 10^{-12} to 10^{-9} cm^3/sec. An auxiliary vacuum system is provided for evacuation of the system under test. (Crosby-Teletronics Corp., Dept. Sci293, 299 Robbins Lane, Syosset, L.I., N.Y.)

■ SIGNAL SAMPLING UNIT, for use with conventional oscilloscopes, makes possible viewing of repetitive pulses with rise times less than 0.5 mμsec on oscilloscopes with 500 kcy/sec band pass. Maximum repetition rate is 50 kcy/sec. A companion unit permits triggering from pulses and sine waves with repetition rates exceeding 300 Mcy/sec. Time stability is said to be better than 0.2 mμsec. Sensitivity is 30 mv/cm with 3-to-1 signal-to-noise ratio. The sampling technique is the same as that used in the manufacturer's model 12 sampling oscilloscope. (Lumatron Electronics, Inc., Dept. Sci294, 68 Urban Ave., Westbury, L.I., N.Y.)

■ SCINTILLATION DETECTOR is provided with an integral transistorized preamplifier capable of driving 500 ft of cable. The preamplifier operates on a small portion of the voltage supplied to the multiplier phototube. Rise time is 0.15 μsec; an internal clipping circuit sets output pulse duration at 1 μsec. Operating requirements include 0.55 ma at 1000 volts, positive high-voltage input, and cable matching impedance of 100 ohm at the amplifier end. Output signal polarity is negative. Interchangeable alpha, beta, and gamma detector crystals can be furnished. (Technical Measurements Corp., Dept. Sci303, 441 Washington Ave., North Haven, Conn.)

JOSHUA STERN

National Bureau of Standards, Washington, D.C.

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Biologist, Ph.D., age 46, associate professor at large university, desires position in western college or university. Active research in comparative physiology. Would welcome opportunity to develop general education biology program. Research facilities and upper division teaching desirable. Box 8, SCIENCE. X

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Information Scientist. Ph.D. in biological sciences, library science degree, pharmaceutical and agricultural industry experience. Box 6, SCIENCE. 1/15

Physical Biochemist. Ph.D. 1951. Research and publications physical chemistry proteins. Energetics, kinetics, mechanisms enzymatic reactions. Steroid isolation, identification, protein interaction. Academic appointment. Available September 1960. Box 268, SCIENCE. 1/8

Microbiologist-Chemist, Experienced; Ph.D., 32. Would appreciate challenging and profitable summer research position anywhere in U.S. Box 9, SCIENCE. X

Microbiol Geneticist, 34, M.S., Ph.D. in 1960. Experience: microbial-genetic research (mutagens, transduction, suppressors); supervisory, genetic control industrial fermentation; interdisciplinary problems. Box 5, SCIENCE. X

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POSITIONS OPEN

(a) **Bacteriologist;** M.S. preferred to head active section, supervise microbiology, some teaching in approved school; 300-bed voluntary general hospital; residential suburb Los Angeles. (b) **Research Bacteriologist;** Ph.D. to conduct basic research on infectious diseases, participate in study and development of synthetic drugs; to about $10,000; prominent eastern pharmaceutical house. (c) **Biochemist;** Ph.D. preferred, new 100-bed general hospital; to $10,800; California. (d) **Research Assistants;** one qualified in biology or chemistry for gynecology department; $6100 start; (e) **Young Recent M.D., Ph.D.,** for experimental pathology division, prefer endocrinology background; $8000 start; new, outstanding eastern research institute, large university city. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

Bacteriologist. Established ethical veterinary drug manufacturer has opening for a bacteriologist with Ph.D. to do new product development and product improvement in both bacterial and virus vaccines. Must be capable of supervising a production installation. Background in tissue culture production desirable. Please send complete résumé. Box 7. SCIENCE. X

Microbiologist III. Vacancy on the island of Hawaii with the plague research program of the State of Hawaii Department of Health. Requires 3 years of experience in conducting bacteriological, parasitological, and serological laboratory tests and analyses and a master's degree with specialization in a biological or medical science; or 4 years of experience as defined in above of which 1 year shall have involved participation in research activities and a bachelor's degree in one of the biological or medical sciences. Appointments may be made at any salary interval between $6156 and $8256 per annum at which a qualified applicant can be recruited. Continuous recruitment until need is met. Write to the Department of Civil Service, State of Hawaii, 825 Mililani Street, Honolulu 13, Hawaii, for additional information and application. X

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The Research Branch of the Canada Department of Agriculture has attractive openings for graduates in the biological and agricultural sciences:

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Agronomy and Horticulture (60-13)
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Post-graduate training is preferred. Starting salaries for recent graduates will range from $4560 to $6780 depending on experience and training. Excellent research facilities and attractive employee benefits.

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For further information write to the Civil Service Commission, Ottawa, Canada, indicating fields of interest and training. Please quote appropriate reference numbers.

Animal Ecologist I. Vacancy on the island of Hawaii with the plague research program of the State of Hawaii Department of Health. Requires 2 years of research experience in zoology, mammalogy, animal ecology, or entomology, and graduation from a college or university of recognized standing with a major in zoology, mammalogy, entomology, or a related biological science. Appointments may be made at any salary interval between $5076 and $6792 per annum at which a qualified applicant can be recruited. Continuous recruitment until need is met. Write to the Department of Civil Service, State of Hawaii, 825 Mililani Street, Honolulu 13, Hawaii, for additional information and application. X

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Prefer member of American College of Veterinary Pathologists; however non-member candidate with broad training and experience in histo-pathology will be considered.

Please send complete résumé
to Personnel Director

SCHERING CORP.

Bloomfield, N.J.

Protozoologist-Parasitologist, Ph.D., and **Biologist,** Ph.D. Experience preferred. Some graduate teaching; research. Roman Catholic university, East. Science building in progress. Write and include résumé to Chairman, Department of Biology, Villanova University, Villanova, Pa. 1/8

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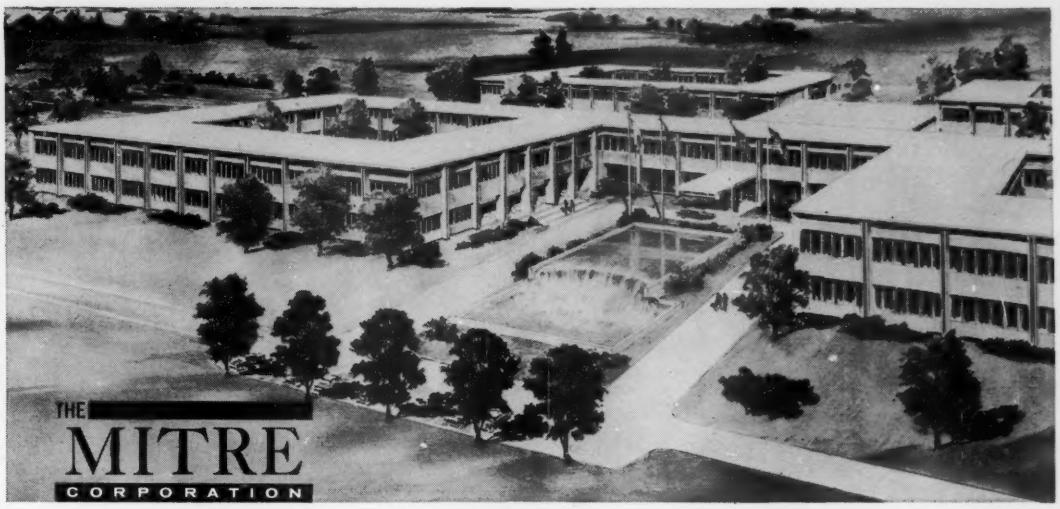

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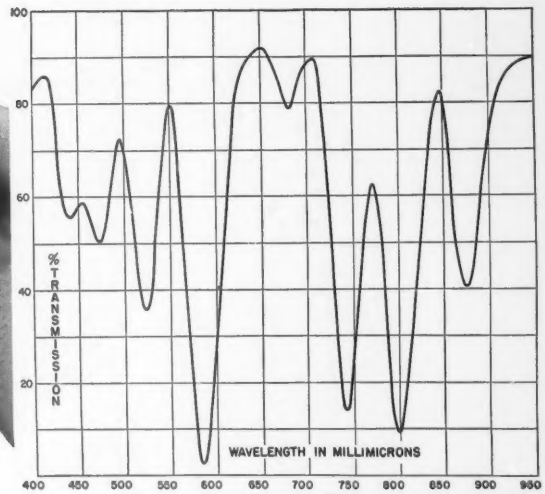

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